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# USSR Report

## SPACE

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## CONTENTS

LAUNCH TABLE

MANNED MISSION HIGHLIGHTS

LYAKHOV AND ALEKSANDROV WORK WITH 'PION' EXPERIMENT ON 'SALYUT-7'

Moscow IZVESTIYA in Russian 1 Oct 83 p 2

[Article by A. Ivakhnov: "Orbital Arithmetic"]

[Text] The regular meeting of journalists with the flight directors was associated with the completion of 3 months work for Vladimir Lyakhov and Aleksandr Aleksandrov on board the orbital spaceship. Viktor Blagov, deputy flight director, offered some interesting statistics: The "Protons" have gone around the earth 1,500 times now, and the meter logging the distance they travel just turned over 61 million kilometers--in conventional terms, of course.

By now, the "Protons" had become genuine sky dwellers. The condition of their organisms was stable, they were on good terms with weightlessness, and their sleep had assumed a normal, uninterupted pattern. But the experience of previous flights indicates that towards the end of the third or beginning of the fourth month in orbit, the cosmonauts begin to feel more keenly the seclusion of space and the monotony of work. And now it seems that such a moment is nearing for the "Protons."

From the very beginning of the flight, a group has been functioning as psychological supports for the crew, making every effort to assure that V. Lyakhov and A. Aleksandrov did not become bored. There were radio and video meetings with their families, with artists, friends, and talks with news correspondents. At the very start of the flight, the cosmonauts, in their enthusiasm for the experiments, often asked for an end to the entertainment so they could have time to get more done. But now these same men are pleading that this be done so that their free time can be filled with impressions from earth.

On average, the "Protons" are each conducting one large-scale experiment per day, repair-maintenance operations, re-dockings, meeting or dispatching of transport craft, orbit corrections, system maneuvers, medical checks, and daily physical exercises. Many experiments have already been described in some detail in our paper, and it is obviously not necessary to list them all now. But you will probably be interested in knowing about one of them.

V. Blagov remarked during his narration that the cosmonauts were taking special interest in working with the "Pion," that they had already conducted three experiments and that now everyone was asking when the next one was planned.

The directors of this project were present at the meeting--V. Leskov, doctor of physical and mathematical sciences, and V. Savichev, doctor of technical sciences. They in their turn asked the flight control to relay the "Protons" the thanks of the scientists for their efforts that had yielded very curious scientific data. Incidently, similar experiments were at first included in the work agenda on board one of the recent American manned space ships but they were cancelled on orders from the Defense Department, and Soviet scientists are the only ones in the world to have the opportunity to conduct such experiments.

The experiments are concerned with the physics of weightlessness. Reports have been written many times now about the fact that, much more successfully under orbital than terrestrial conditions, unique crystals grow from melts, resulting in alloys, glasses, and semi-conducting materials with previously unknown properties.

Then vials of materials acquired in orbit came down to earth, where it was seen that physical processes within the vials do not proceed exactly the way scientists supposed and the way we journalists report their words in newspapers. If it were somehow possible to look inside a vial while a new alloy was forming there, what could be seen going on?

Scientists devised a way. A "Pion" [R. peony] has nothing in common with the flower. The first letters of its [Russian] name just turn out that way. It is called a device for investigation of peculiarities of weightlessnesss. Instead of a vial, a dish made of transparent material is placed in it. A light source is located at one side of it, and a movie or photo camera is at the other side. There is a small window through which can be seen what is going on inside. A special sensing device measures temperatures at different places outside and inside the dish. A clock is mounted inside the device, and on the frames of the films one can see a tiny clock face showing the exact moment the photograph was taken.

The most important component of the equipment for this experiment are the mico-acceleration sensors. In everyday language, they are devices that register the most minute vibrations of both the "Pion" and the space station as a whole. Let's imagine that the experiment is in progress and that a cosmonaut sat down hard in his chair or turned on some other piece of equipment or, say, that a micrometeorite struck the body of the ship. For humans, many such jolts are imperceptible, but they can be fatal for the growing crystals. Therefore, the micro-acceleration sensors register even the switching-on of "Pion's" movie camera.

I don't think there is any need to describe the device's control system equipment which programs the unit. Let's imagine that we are "Protons" and are putting the next dish into the device to watch what takes place in it.

But first I'll describe what kind of dish this is. It is a flat, circular container filled with liquid, in which a flattened gas bubble floats--without the container, both the gas and the liquid would be spherical. In it are also fine particles of matter whose density is the s ame as that of the liquid.

There is one other thing to be added at this point. Earlier experiments have shown that, although light gases rise on earth--air bubbles in an aquarium are a graphic example--they don't know how to behave in a condition of weightlessness. Thus, when the liquid moistens the walls of, say, the aquarium, the bubbles accumulate and merge in the center of the container. We must confess there was such an aquarium in orbit. The fish rushed, to the central gaseous bubble in order to "breathe" and feed. But no one nad thought about putting food there.

If there is no liquid to moisten the vessel walls, the gaseous bubbles go to the periphery. The sphere of gas in our dish floats at the circular wall.

While the dish was located somewhere behind a partition and the temperature of its entire mass was constant, the specks of matter in it were motionless. But we began to apply heat to the dish in the device. After a few minutes, the particles in it started to whirl in a pretty ring dance to the left and right of the gas bubble.

It's understandable why the "Protons" show such enthusiasm for this experiment. They might of course be on the threshold of an interesting discovery.

Viktor Dmitriyevich Blagov told us that the monotony of a flight can be relieved not only by contact with a human being--however interesting the person might be--but also by some kind of extraordinary experiment. The work with the "Pion" is occupying the minds of the "Protons" in just this way. Everything taking place in this device will someday be the property of all men, but they are the first to see it with their own eyes.

9992
CSO: 1866/37

MATERIALS STUDY EXPERIMENTS WITH 'ELEKTROTOPOGRAF' ON 'SALYUT-7'

Moscow PRAVDA in Russian 14 Aug 83 p 6

[Article by A. Pokrovskiy, special correspondent to PRAVDA: "A Look Into the Future"]

[Text] How are you feeling, station? A reply to such a question could be simply: at present the crew is feeling fine, while the station, which is protecting the crew from the deadly surroundings of space, is completely "healthy". Judging from everything, Vladimir Lyakhov and Aleksandr Aleksandrov are not complaining of their health. This is also evident from the volume of work they are performing and by their conversations with the Flight Control Center. It seems that the unloading of 'Kosmos-1443' has given them some muscle. The Commander has even put on some weight, while the engineer's loss is quite insignificant. They transmit amiably to Earth:

--When possible, please send more vegetables and fruits, and the meat ration may be decreased...

Well, what about the station? Multiple sensors have their "hand at the pulse" constantly. The telemetry data, which is transmitted around the clock to the Flight Control Center, indicate that here everything is also well, although in space the station is subjected to literally a shower of harmful influences. For example, it has been calculated that at least one micrometeorite strikes each square centimeters of its surface once a month. Added to that are the sharp changes in temperature in the darkness and the sun, intense ultraviolet radiation, corpuscular streams and a number of other space factors.

The sensors installed onboard the spacecraft cannot report in detail about their influence via telemetry data. The station or the cargo ship cannot be rolled into some laboratory for comprehensive testing. Moreover, the increase in the duration of space flights has made the problem of supplies of construction materials for maintenance in orbit more accute. The development of space science has also made the problem of building long-term, if not permanent, space stations of various function more important. But what materials would be best for assembling such stations?

For example, cosmonauts have noticed that over time the transparency of the glass in the viewports decreases. "Pock marks" from the impact of micrometeorites are not the only problem (one of them, by the way, struck the

viewport near V. Lyakhov and A. Aleksandrov); the film on the viewports also influences the operational quality of the film and photo equipment. Specialists disagree as to the origins of the film. Some believe that they are the result of the action of space radiation, while others believe they are from the residual matter left from the spacecraft engines.

Indirect indicators indicated that over long-term space flights, the properties of the external heat control coating also vary; according to the specialists, the material breaks down. In a word, specially-designed, sequential experiments in space were required. They began with a simple approach. During one session of extravehicular activity, the cosmonauts were asked to remove a sample of the film from the viewport. It didn't turn out: the film was glued fast to the glass.

It remained to select the material samples, place them on the surface of the station, and then remove them and return them to the Earth for testing. Such an operation was begun. Predecessors to V. Lyakhov and A. Aleksandrov on 'Salyut-7'--A. Berezovoy and V. Lebedev--participated in this operation. However, such a sequence of experiments did not yield all the necessary data. First of all, extravehicular activity is a complex operation, and is not often performed. Secondly, the samples that were taken and held on-board for return to Earth changed their properties to some degree.

It was here that the 'Electrotopografh' device, which had proven itself so well in ground conditions, came to the rescue. Its principle of operation is based on a new method of recording microdefects developed by A. Kravtsov and M. Reznikov in the Department of Physical Electronics of the Institute of Physics of the Academy of Sciences of the Ukrainian SSR. They discovered that if the test material is attached to a photoplate and they are inserted into an electrical field, following the development of the plate it is possible to see an image of the electrical and geometric inhomogeneities and defects in the material. The pores, cracks and various inclusions less than 1 micrometer in size are noticeable in such an electrotopogram.

The primary advantages of electrotopography include non-destructive operation, and high efficiency and information yield. The methods and equipment used for such monitoring are protected by eight inventor's certificates and five certificates for industrial samples, and have saved the enterprises of the electronics and electrotechnical industries two million rubles.

But could such a device operate as effectively in space! The Ukrainian scientists have old and close contacts with space researchers--we recall the "Vulkan" and "Isparitel'" devices. And again this time B. Paton, president of the Ukrainian SSR Academy of Sciences and M. Shpak, corresponding member of the Ukrainian SSR Academy of Sciences and Director of the Institute of Physics lent every assistance to the creation of a space variation on the 'Electrotopograf'.

"It was manufactured in our Special Office of Technological Design [SKTB] for Physical Instrument Construction" recalls A. Kravtsov, "we had some difficulty in meeting the stricter requirements on reliability and maintenance simplicity

on the equipment, as well as on decreasing its weight and size. And this is what is interesting. When we implemented these, what would seem to be strict, space specifications, it turned out that such a variation on the device was more economical and simpler to use: it could find wide application in industrial enterprises.

It remains to be added that the scientists also took samples of constructional and model (for a 'targeted' study of the influence of separate space factors) materials, and mapped out a program of study for these materials. A methodology for the experiments was also created. Now the cosmonauts do not have to go outside of the capsule. They place a platform with twelve samples into a lock chamber, leave the platform in the chamber for a time period set by the program, and then move the samples to the equipment and taken the electrotopogram. The samples are then again placed in the chamber which is open to the external space environment, and specific changes are again recorded.

Lyakhov and Aleksandrov were enthusiastic about participating in this first experiment in space.

"It's our favorite instrument!" was Vladimir Lyakhov's comment on the "Elektrotopograf".

"The 'Protons' operated without a hitch," remarked A. Kravtsov, "this testifies to their capacity and the quality of the manufacturing on earth".

Meanwhile, Lyakhov and Aleksandrov showed their abilities as space cargo handlers. But this time they loaded the cargo in the other directions: from the station to the 'Cosmos-1443". Soon they will be leaving the space station, and their return craft is to bring back to Earth scientific data obtained over the month and a half of operation of the 'Protons'. Included in them will be a series of electrotopograms, the first ones from space. Scientists are already awaiting these. Waiting to get a glimpse into the future of space stations.

12576
CSO: 1866/29

COSMONAUTS EVALUATE COLOR RESULTS FROM 'ELEKTROTOPOGRAF' EXPERIMENT

Moscow IZVESTIYA in Russian 18 Oct 83 p 2

[Article by IZVETSIYA special correspondent A. Ivakhnov: "If You Check on an Atlas... Reportage from the Flight Control Center"]

[Excerpt] The staff of the Ukrainian SSR Academy of Sciences Institute of Physics detected an interesting phenomenon. It seems that an electric field also affects photographic film, just like light waves. If a thin layer of some material is placed next to the film and they are mounted together between the plates of a condenser, all the defects in the material are recorded on the film, even those that can be seen only through a microscope. On this basis a promising method was developed for nondestructive inspection and it is already be used in many sectors.

The space equipment designers went to the Ukrainian physicists asking for help in using this method to observe the condition of materials that in orbit are bombarded with micrometeorites and subjected to the effects of the atmosphere surrounding the station and all possible kinds of radiation. A group of designers at the institute led by Vitaliy Vadimovich Permyakov quickly developed the compact "Elektrotopograf" instrument.

V. Lyakhov and A. Aleksandrov conducted this experiment with particular diligence: first it was interesting in and of itself, and second, its results are important for the development of the sector to which the "Protony" have devoted their lives--cosmonautics. The cosmonauts pushed samples of materials through an airlock into open space for specific periods and then brought them back in, made electrotopograms and then again pushed the samples outside... From the films it is possible to trace how the structure of the samples and their phsyical properties altered under the effect of space factors.

The samples themselves and numerous prints of them were delivered back to Earth aboard the "Cosmos-1443" freight-recovery vehicle. The designers of the instrument must be given their due, as must the workers at the physics instrument-making special design and technological bureau who made it: everything worked splendidly, and although it was the first instrument that had been developed at the institute for operation under weightless conditions the quality of the developed prints was better than the control prints obtained under terrestrial conditions.

The most interesting part starts here. Samples made from the same material but of different thicknesses differed at first in terms of light and their optical properties. However, after being left outside the station for a long period these properties equalized, as it were. It is a pity that the cosmonauts were not asked earlier to investigate the color of the films changed after each exposure, for that would also have yielded important information. But here is the mystery: on the electrotopograms made after the samples had been outside the station for several hours a shadowing can be seen in the form of little stars and eight-sided shapes measuring several millimeters across, but on subsequent films they became paler and after prolonged exposure of the materials they were not visible at all. Where do they come from and what do they signify? There is, as yet, no answer to this question...

During the communications sessions the "Protony" were always asking, "well, what have you found on the electrotopograms?" And when they were told about the results of the experiments they made the following suggestion:

"We still have some plates and samples. Let us repeat the experiments but broaden them. After the samples are brought back in from open space we shall photograph them on color film. We have the equipment: we thought that we would take pictures of each other for the family albums, but this is more important..."

And there was an even more successful coincidence: work with the "Elektrotopograf" at this new stage was done simultaneously with the "Tsvet" experiment. We have written about this also: the cosmonauts observe the color of specific parts of the Earth's surface or oceans and compare it with reference colors in an atlas they have with them, and report to Earth the serial number of the corresponding reference color.

It was A. Kravtsov, the scientific leader of the "Elektrotopograf" experiment who first had the idea: the changes in the color of the plates could be matched against the colors on the reference atlas! This also makes it possible to obtain important characteristics of the model materials such as the length of the reflected wave and the reflection factor. And from this it is possible to make a judgement on what is going on inside the plates.

As a control the cosmonauts were asked to find in the atlas the color analogues of the unexposed samples, and the same was done back on Earth. Everything matched. And the work was done and the data sent back to Earth--the sort of data that they had not dreamed of when the experiment was being set up. The "Protony" deserve the highest praise: they were only given enough time in the experiment to operate the instrument itself, and it was impossible to extend this time, for much other work had been planned and time alloted for rest. But they still prepared the camera equipment, thought about how best to illuminate the samples, selected the exposure time and aperture setting, and when working on other experiments, when they scarcely had a free minute, they contrived to do the photography, compare the samples with the atlas, and themselves suggested that the exposure time outside the station be increased. Aleksandr Yevgen'yevich's mission time had long since run out, but he could not leave it when his child, his experiment in orbit produced such a burst of enthusiasm...

When this second series of experiments was completed and the cosmonauts reported that they were packing the samples and the film for their return to Earth, the deviser of the experiment thanked them for their outstanding work and their invention and said that the entire collective at the institute would be waiting for them and was hoping that the data obtained could be processed with the "Protony." And then the duty communications officer picked up the microphone: "I have been informed that the leadership of the Ukrainian Academy of Sciences Institute of Physics now counts you as part of its scientific staff."

"Senior or junior?" the flight enquired.

"Honorary..."

9642
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RESULTS FROM FIRST SERIES OF 'ELEKTROTOPOGRAF' EXPERIMENTS

Moscow PRAVDA in Russian 16 Nov 83 p 3

[Article by A. Kravtsov, scientific director of experiments and candidate of technical sciences, and M. Shpak, corresponding member of the Ukrainian SSR Academy of Sciences: "Our Commentary on 'Salyut-7' -- to the Space Construction Sites"]

> [Text] In August the shuttle craft "Kosmos-1443" delivered to Earth results of experiments conducted by V. Lyakhov and A. Aleksandrov during the first half of their flight. Among them were materials from the "Elektrotopograf" experiment. The films have now been turned over to the Institute of Physics of the Ukrainian SSR Academy of Sciences, the lead institute for this research program.

We will admit that scientists from the institute who developed the scientific part of this program and associates of the special design-technological bureau [SKTB] of physics instrument-making who originally designed the "Elektrotopograf" for space research were worried about the following questions: Did the instrument work well under conditions of weightlessness? Was the film ruined by exposure to light? Were the standard samples and intervals of their exposure in space selected correctly?

This is understandable. After all, the "Salyut-7" was the first in world practice to conduct a direct experiment to study the dynamics of the effect of space factors on design materials. While conducting the experiment, Vladimir Lyakhov and Aleksandr Aleksandrov had to carry out many fairly complex and delicate operations for the first time, involving bringing the samples being studied out into open space periodically and returning them to the station using the lock chamber, studying samples on the "Elektrotopograf" instrument after each exposure, and replacing the used film.

Nevertheless, our worrying turned out to be in vain. Good quality electrotopograms of all 12 samples were obtained after five successive exposures in open space. Undoubtedly, the high responsibility with which the "Protony" approached conducting the new technological experiment had an effect here.

When we began processing the results of the "Elektrotopograf" experiment, we found a number of interesting patterns which characterize the dependence of

the degree of destruction of the standard film samples of the design materials under study on increase in their thickness and time spent in open space. Staff members of the Flight Control Center advised "Protony" of the positive results of the first experiment. The latter responded in this way: "We're ready to conduct the second 'Elektrotopograf' experiment according to the corrected program."

I would like to digress a little here. Increasing the duration of the orbital journey made it possible to move to a qualitatively new organization of scientific research. Of course, it is important to scientists who have received the first results of experiments to refine or supplement the data obtained. It is desirable here to have the participation of the same cosmonauts who began the project. This is what happened with the "Elektrotopograf."

While thoroughly processing the results obtained -- using modern scientific instruments to compute and process the data recorded on the film, in particular the French "Perikolor" device -- we began writing a program for continuation of the experiment. And then the "Protony" once again went to work on the "Elektrotopograf."

What is the essence of the experiment? It is common knowledge that in open space a whole number of destructive factors influence materials and design elements: exposure to quantums of ultraviolet radiation and streams of protons and electrons; the effect of meteorites and temperature drops; and interaction with chemical substances in the atmosphere near the station. The "Elektrotopograf" is also expected to answer the question of the dynamics of the effect of these factors on base design materials. Generalized physical models of them serve as research objects -- multilayer thin-film compositions which have the same chemical mechanisms of destruction in space as the design materials, but differ in that they generally break down much faster. Based on the results of this research, scientists propose to construct a physico-mathematical theory of the kinetics of the destruction of materials in space, which will enable the developers of space technology to decide on the merits of using e type of materials or another.

I would like to note that our institute not only discovered and studied a new phenomenon of the sensitivity of a photoemulsion to the effect of a heterogeneous electrical field, but also developed a number of methods and procedures for nondestructive control for the national economy and built a series of "Elektrotopograf"-type instruments. The control techniques and devices are protected by eight author's certificates and five certificates for industrial samples. They are used at a number of enterprises in the electronics and electrical equipment sectors of industry. The economic effect of their use is already more than 2 million rubles.

Now about the second part of the space experiment. Films which are more sensitive to an electrical field were utilized here. In order to increase the information content in interpreting the electrotopograms and registering the images of irregularities recorded in the first experiment in the layers under study, which emerged after 30 hours of exposure in space in the form of "fans," "stars," and "figure-8's," at our request V. Lyakhov and A. Aleksandrov independently

worked out a technique for photographing samples on colored film and put it to use after each successive exposure in space. They worked out and used techniques for determining the fluctuation in the length of a reflected wave and for determining the coefficient of reflection of the surface of the samples under study as a function of their thickness and exposure time in space.

V. Lyakhov and A. Aleksandrov carried out all the operations precisely and smoothly, and exhibited extensive experimental skills and good professional training.

The latest cycle of technological experiments on the "Elektrotopograf" on board the "Salyut-7" was successfully completed. The "Protony" themselves will deliver the films and samples to Earth; they will share their knowledge about conducting this research in conditions of weightlessness with specialists, make suggestions for improving the instruments, and take part in processing and interpreting the results obtained.

12,424
CSO: 1866/45

DISCUSSION OF COSMONAUT EVA FOR SOLAR BATTERY INSTALLATION

Moscow IZVESTIYA in Russian 4 Nov 83 p 2

[Article by A. Ivakhnov: "Above the Abyss Once Again--Report from Flight Control Center"]

[Text] Not two days have passed since specialists gathered at Flight Control Center applauded the completion of a complex installation operation which V. Lyakhov and A. Aleksandrov executed in open space. Early on the morning of 3 November we are again on the balcony of the main hall, and the little blue star on the map, moving in a sine curve, approaches the conventional sign that indicates that at this point of its orbit the "Protony" will once more open the round door into the cosmic abyss.

Just like the day before yesterday, beneath the map a model of the solar battery with a copy of the supplemental unit which the "Protony" are to install rests on numerous stanchions long the full length of the hall. On the balcony near a huge globe stands a snow-white pressure suit with a lowered golden visor, and experienced cosmonauts are telling journalists about its merits.

It seems as if you are looking at a film you have already seen. Here the commentator explains once again that during the time the orbital complex is flying above the ships "Cosmonaut Vladislav Volkov" and "Cosmonaut Georgiy Dobrovol'skiy," which are now keeping watch in the Atlantic, communication will be conducted with the aid of the "Sapfir" system. Now is not the time to explain the technical features of this system, but it must be said that people's voices are distorted during such transmission and you must speak very slowly for the person you are talking to to be able to understand you.

It is time! Far, far away above the expanses of the Pacific Ocean and high, high up -- more than 300 kilometers from the surface of the water, the "Protony" are again opening the exit hatch of the orbital station. Just like the last time, they will first complete a whole series of preparatory operations and work with scientific apparatus and then, having announced to "Zarya" that they are ready to complete the main operation, they will get to work with the supplemental solar battery.

Deputy flight director V. Blagov told the journalists that installaion of such supplemental elements which increase the power capacity was planned even

before the "Salyut-7" orbital station was launched. Ways to secure them were figured out, winches that are compact and convenient to operate were designed, and the installation procedure was developed. Rather bulky containers with the solar batteries were delivered into orbit by the supply ship "Cosmos-1443." The day before yesterday, after "Protony" had installed the first supplemental "wing," 4.6 square meters were added to the 50 square meters of total area of solar batteries. Today this "addition" is being doubled.

"All of this," said Viktor Dmitriyevich, "is important for two reasons. In the first place, solar battery elements gradually lose their productivity when they are operated in space for a very long time, owing to the effects of radiation, micrometeorites, dust, and the internal atmosphere of the complex. We understood this very well some time ago, during the flight of the 'Salyut-6' station. Moreover, technological units and instruments which require more and more energy are being sent into orbit. Now, for example, a new "Korund" oven is aboard, into which it is possible to put at one time a dozen samples, and of much larger diameters than earlier designs of ovens allowed.

"In the future we will begin to attach special scientific modules which also require a great deal of energy. And today's installation operations are the very first steps in solving the orbital energy problems facing us.

"Well then, in the second place, although all kinds of maintenance work has been carried out in open space before, up to now such major installation operations have not been conducted. After all, the time is not far off when brigades of installation workers will fly into orbit and build large orbital complexes in space. The 'Protony' have already proved that all this is completely feasible."

The little blue star entered the oval which designated the communications zone of the first of the duty ships along its route.

"Pro-ton-y. Re-port your si-tu-ation," the communications operator addressed the cosmonauts, dragging out his words. Unfortunately, we do not hear the answers. However, the commentator reports that everything is going according to schedule and the cosmonauts are feeling well.

The "Protony" are working precisely and smoothly. It is said that during training in the hydrolaboratory they executed all these operations 12 times. It was planned that during the first EVA they would carry out all the work in two revolutions, but if there were delays they would remain in open space for a third also. But they completed everything ahead of schedule.

We must give them their due for their powers of endurance also. In certain instances after the most intensive work on board the station we heard their heavy, quickened breathing through the loudspeakers and then the medics said that their pulses at this time were up to 120. But upon returning to the station they did not rest at all because they had to immediately begin preparing for another EVA. They got their pressure suits in order -- dried them out with the aid of fans, replaced the elements in the life-support systems, and checked to see that they were working. The next day they had a medical exam, station systems check, a check to see that everything they would take out was in working condition, and stowed it in the transfer compartment. In

a word, there was no time for them to get bored. And on top of it all, their usual daily regime was disrupted: they were used to living on Moscow time, but the evening before the EVA they had to go to bed after lunch and wake up just before midnight.

At last the complex is over the Mediterranean Sea, in the communications zone of the ship "Cosmonaut Yuriy Gagarin," and the long-awaited, ordinary loudspeaker is turned on.

The "Protony" are preparing to install the additional block of the solar battery. They talk among themselves mainly, and this conversation reflects their brotherly relationship to each other very well, I would say. "Wait, Sashok, that's awkward for you. Let me do it. I'll swim up from the other side." "Stop, Volodya. I'll adjust the line. It'll be easier for you."

The "accordion" of the supplemental block is stretched out alongside the second solar battery.

The blue point on the map is crossing our Far Eastern borders. Soon the communication session will be at an end.

"Protony," says the radio operator. "While you are out of communication with us, dismantle the auxiliary equipment and finish up work with the scientific apparatus. And show us the station and your ship during the televised session on the next revolution."

On the huge color television screen we see a solar battery with the supplemental panels mounted on two of its sides and the flight engineer waving to us in greeting.

"We are happy," say the "Protony," "that it was we who were entrusted with this crucial work. The installation operations we performed are the beginning of an extensive program for building large structures in orbit. And now we'll try to show our ship from different sides."

"Sasha, don't get carried away. You don't have to climb up there," the communications operator begs. "It's time for you to move to the transfer compartment. Everyone's satisfied with your work here. You're simply great guys!"

All the work is completed and the crew is returning to the "space house." One other thing has been accomplished -- a new phase in the development of the orbital scientific complex has begun.

In conclusion a few statistics. Twelve Soviet cosmonauts have gone out into open space since the beginning of the spage age. The flight engineer of the crew working in orbit today, A. Aleksandrov, has been there twice. And today commander V. Lyakhov became the first person to do this for the third time. We congratulate him warmly for his record!

12,424
CSO: 1866/43

DETAILS OF COSMONAUTS' INSTALLATION OF SOLAR BATTERIES

Moscow PRAVDA in Russian 4 Nov 83 p 3

[Article by V. Vladimirov, designer: "'Salyut-7 -- Our Commentary -- Space Installers"]

[Text] On 2 November current from the supplemental solar battery installed on 1 November by Vladimir Lyakhov and Aleksandr Aleksandrov flowed into the electrical system of the "Salyut-7" -- "Soyuz T-9" -- "Progress-18" space complex. And on 3 November they again went into open space and installed another battery, but on the other side of the main panel. As a result, its power was increased by one-half. An important step in the development of space technology was taken.

Manned long-functioning orbital complexes are the main direction of the fatherland's cosmonautics. Accumulated experience and the increasing periods of time they have been in operation have made it possible to improve results of experiments and expand the range of problems being solved. This requires increasing the number of instruments on board an orbital complex and, as a rule, additional electrical energy is needed for them. Where will it come from?

Let us recall the not too distant past. On the first artificial satellite in the world, the Soviet satellite which was launched on 4 October 1957, 38 percent of the total weight was made up of chemical sources of current, and there was enough for three weeks. From the first steps in the development of cosmonautics designers faced a complex question: what type of energy sources should be used on board? And here the outline of cosmonautical power engineering gradually emerges.

These days transistorized photoelectric cells which transform solar radiation directly into electrical energy provide the power supply for space equipment along with electrochemical sources of current and radio-isotope and other electrical generators. In hardly more than eight minutes free energy from the reactor we call the sun reaches the solar battery panels.

There are two ways to increase the efficiency of the solar batteries being used today: increase the efficiency of the photocells used on them, and increase the panel area of the batteries operating in space. Whereas increasing the efficiency of cells is an exclusively earthly concern, the cosmonauts themselves,

the "landlords of the orbiting house," can augment the solar batteries. The second way is especially attractive for its far-reaching possibilities for practical use.

Our planet's restricted fuel resources compel us to return to the problem of building powerful orbital electrical plants, which no longer seems insoluble in practice today. The fact that the cosmonauts themselves augmented the energy of the station may be regarded both as a first attempt to solve a global problem and as a practical contribution to increasing the operating efficiency of orbital complexes. Such an installation operation was carried out for the first time in world cosmonautics by the cosmonauts V. Lyakhov and A. Aleksandrov.

Support for this unparalleled operation was begun on Earth. On the main panel of the solar battery they installed a hinged arm with a winch mounted on it, a specially laid cable, and mounting assemblies for suspending the supplemental panels. The "Cosmos-1443" ship delivered two supplemental solar battery panels aboard the station. Each of them was placed in a container with handles for transporting.

Both of the cosmonauts' EVA's to do the installation were performed using a uniform procedure. The flight engineer left the orbital complex first. He took a container with a supplemental solar battery panel and the mounting tools from the commander and secured them to the outside of the station with a line so that they would not fly away. After moving about six meters along the handrails, Aleksandrov secured himself at the place where the panel would be installed. Coming out of the hatch, Lyakhov transported there and secured a container and tools, including special poles with a movable base and cutters. At that point Aleksandrov was preparing a place for the work to come. He opened the securing points (the "anchors") and the special exterior handrail. Everything was ready for the main operation!

The commander and flight engineer took the container and, using two fixing pins, mounted it on the face of the station's main solar battery panel, manually connected the sockets of the power supply system, and fastened the end of the main panel cable to the holding pin of the supplemental one. Then Lyakhov went to the safe zone using the handrails and secured himself to the "anchor." Slowly turning the crank of the winch, as if on a flagstaff, Aleksandrov expanded the supplemental panels along the web of the main solar battery. The fixing pins of the supplemental panels went into the latch opening at the top end of the battery. Installation of the supplemental panel of solar batteries to the station was complete!

After completing the main operation the cosmonauts mounted a screen on the supplemental panel to protect it from the glare of the sun, which can hinder orienting the station's solar batteries. The only thing left to do was to put the batteries into working position.

At first glance the operation in itself does not seem complex. But in fact it demanded a great deal of effort and precision from the cosmonauts at work. Of course, such operations, especially in the first stages, require thorough training on Earth. Methods of working in space were repeatedly worked through

in the hydrotank. The designer-developers supervised each stage carefully, making corrections in the procedure.

Successful completion of installation work outside the station increases the range of activity of man in orbit, making it possible to substantially improve the design of orbiting complexes already in operation and expanding their potential.

12,242
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LANDING OF 'SOYUZ T-9' COSMONAUTS

Moscow IZVESTIYA in Russian 25 Nov 83 p 3

[Report by IZVESTIYA special correspondent A. Ivakhnov: "The Road Home: Reportage from the Flight Control Center"]

[Text] Cosmonauts Vladimir Lyakhov and Aleksandr Aleksandrov are back home on Earth! On 23 November at 2258 hours Moscow time we heard their happy voices in the loudspeakers at the control center: "Touchdown... Complete! We are lying on our side..."

The "Protony" carried out their watch in near-earth space for 150 days. Several days ago at the flight control center journalists were given copious lists of the experiments and observations conducted by the cosmonauts during their 5-month mission, with indications of the number of pictures taken and the most valuable materials, holograms and electrotopograms and telemetry data. Several pages of typewritten text, and each line, on the one hand, representing the tense work of the scientists, designers and experts who developed the unique instruments and equipment, and the tense work of the "Protony" in orbit with this equipment, and on the other hand, representing the results obtained, which--and there is no doubt of this--will make it possible for the various sciences to advance to new and very advanced frontiers.

"What in the work of this expedition was important for the future of cosmonautics?" Journalists asked this question of mission controller, pilot-cosmonaut of the USSR Valeriy Ryumin.

"In terms of flight duration," Valeriy Viktorovich said, "the 'Protony' did not set any records; and this was not planned. I would name as one important stage of their mission the work with the "Cosmos-1443" support vehicle. For the first time a module almost as big as the orbital station itself made up part of an orbital complex, and it was the first time that we have been able to recover send such a large amount of material equipment from orbit and bring it back to Earth. In addition, for a long period all orbit corrections and orientation of the complex were done with the aid of the "Cosmos-1443" engines, thanks to which the service life of the station was considerably prolonged. The 'Protony' gained valuable experience in the servicing of large vehicles.

"And of course, we must single out from the entire program the work to install the extra solar batteries, which was basically new and the most complicated

work in the history of spaceflight. In the unanimous opinion of the specialists, Volodya and Sasha carried out this work brilliantly and they deserve the highest praise."

"What did the cosmonauts do in the final days?"

"They had much work to do: stow scientific apparatus, pack freight that was being brought back into containers and stow it in the descent apparatus, conduct a 'general tidying up' of the station, transfer worn-out equipment and other waste to the living compartment (they had collected quite a lot), study the flight-landing documentation, and together with specialists at the flight control center carry out a training "landing", check the operation of the "Soyuz T-9" systems and prepare the station for operation in unmanned mode.... In addition, it was necessary for their bodies to be prepared for the return to conditions of terrestrial gravitation by doing special physical exercises and working out in the 'Chibis' pneumatic-vacuum suit. They had to work a fair amount but the 'Protony' did not complain of fatigue. They understood that each operation was another step along the road home..."

And then it arrived: the day of farewell with the "Salyut-7" station. "'Protony' this is 'Zarya.' How do you read?"

Moving along a sinusoidal track the little blue star intersects the outline of an oval that designates the zone of radio communication with the tracking station located in the area of Ussuriysk. The cosmnauts report: "Pressure suits secure, airlocks closed."

"You are cleared for undocking at the planned time. Keep us informed..."

"Undocked! It went smoothly, we have the station in view on the screen."

There was adequate free time before the next communications session and we asked one of the designers of space technology, professor S. Grishin, to tell us, from his viewpoint, what had been noteworthy about the mission now nearing completion.

"It was an important step along the long road that manned cosmonautics has come," said Sergey Dmitriyevich. "Let us take a mental look at the future."

"... Refuelling bases are located in various high and low orbits. Their fuel supplies are delivered by space tugs that carry all possible kinds of freight to the orbital factories, the multiple-module scientific stations and the building berths of interplanetary vehicles. Powerful optical telescopes and radar installations study the Earth's resources and monitor the development of natural phenomena. Orbital solar-electric power stations store energy and with the aid of SHF or laser beams transmit it as required to their space consumers."

"Of course, to create all this will require the work of an army of space construction workers--welders and assemblers. We have experience of welding work in orbit and now the 'Protony' have confirmed that assembly operations in space are quite feasible."

By long-standing tradition during the final stage of a mission the communications microphone is held by the chief of cosmonaut training, pilot-cosmonaut of the USSR V. Shatalov.

"Well," jokes Vladimir Aleksandrovich, "can you fit into the seats, you haven't put on weight or grown plump during the flight? Here are the data on the landing site. The touchdown area is the usual one, all the bumps have been flattened out. There is stratus cloud but a little fog cannot be ruled out. It is the middle of the night there now. If the recovery group fails to arrive in time do not wander far from the descent apparatus. The burn for the braking engines will be over the South Atlantic and will be monitored from the "Kosmonavt Vladislav Volkov" scientific research ship which is waiting for you there. Good luck from us!"

The commentator at the control center reports: "I am informed that the braking engine has fired. Impulse is 25 meters per second... 85... 110. Burn complete. The space vehicle is on its landing trajectory."

The map on the big screen is changed. Now it shows part of the Kazakh SSR. The line representing the descent trajectory runs southeast of Dzhezkazgan city. Ten aircraft, 15 helicopters and 5 search-and-recovery installations with technical specialists and doctors on board are waiting along the flight path. The shortwave centers of the USSR Ministry of Communications are taking bearings on the descent apparatus. The bearing suddenly fades--the space vehicle's instrument and power unit compartment has separated. Now we hear the voices of the "Protony" again, just for an instant, before the plasma stream blankets the descent apparatus as it moves into the dense layers of the atmosphere.

"Everything is fine," we hear from the loudspeakers. "Separation took place just a second ago. We are beginning to feel g-load."

Now the automatic landing system is in control. The yellow star intersects Amu-Darya, Syrdarya. They report that the cover of the parachute system has been jettisoned. Commincation is restored.

"G-load falling," reports Vladimir Lyakhov. "We can feel a wobble. The vehicle is humming..."

Another report: the parachute system has deployed. A search helicopter is tracking the descent apparatus from the bearing signals. The control center has completed its mission, and now we hear the "Protony" talking to the helicopter captain.

"We are in parachute descent... Everything OK on board, we are fine. We are rocking about like a boat. Do you have us in sight? What do you think our altitude is?"

A report from the landing site: the fog at the landing site has increased and this may hamper the recovery. Meanwhile, the "Protony" are now almost on the ground. The main parachute has been jettisoned.

"And you still have not landed?" the cosmonauts ask the people in the helicopter. "That means we will have to wait..."

They were pained, of course, but after a few seconds they are already laughing merrily and happily in response to some joke. For after their long absence they were again back on Earth.

9642
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FLIGHT DIRECTOR RYUMIN ON ACHIEVEMENTS OF 'SOYUZ T-9' FLIGHT

Moscow PRAVDA in Russian 20 Nov 83 p 6

[Article by A. Pokrovskiy: "Reporting from the Flight Control Center -- Soon To Be on the Way Home"]

[Text] Today is a milestone day for "Protony." Behind are almost five months of flight and numerous astrophysical, geophysical, technical, technological, and biological experiments. Ahead are the final days of work in orbit, which for the most part involve preparation to return home. And this means that V. Lyakhov and A. Aleksandrov must busy themselves with their transport ship and stow materials there which are to be delivered to Earth and, after preparing the station for automatic flight, partially shut down "Salyut-7."

"All this time," flight director V. Ryumin explains, 'Soyuz T-9' was docked with the 'Salyut-7' station and ready to deliver V. Lyakhov and A. Aleksandrov to Earth on any day if necessary. All systems of the ship were and are in good technical condition or, as they still say, have not exhausted their resources. This was confirmed by painstaking tests carried out by the developers of the corresponding ship systems."

"What features of the near-Earth trip of the 'Protony' would you care to note?"

"In such cases one always draws attention above all to new operations which the cosmonauts are carrying out and which their predecessors did not have to deal with. In this case this is the installation of the solar batteries and the work with the transport ship 'Cosmos-1443'. The first operation was the most complex that cosmonauts have had to perform outside the orbital complex. Vladimir Lyakhov and Aleksandr Aleksndrov carried it out brilliantly. And the direct practical result? -- an increase in direct electrical energy on board is not the only point; very promising experience in carrying out complex installation operations in orbit was accumulated. Well, the use of 'Cosmos-1443' made it possible to conserve the resources of the station appreciably, to deliver more reserve supplies there, and -- not least important -- to return more materials obtained as a result of scientific experiments to Earth."

It appears that the specialists quickly directed their attention to this feature of the long expedition. PRAVDA has already explained that in the final stage of their journey the "Protony" again conducted experiments with the

"Elektrotopogrof", but now with a program that had been corrected by scientists taking into account the results of the initial experiments. Approximately the same thing happened with the "Tavriya" experiment, also one of the final ones conducted by the "Protony" in orbit.

The essence of this work is division of complex substances using electrophoresis. A. Berezovoy and V. Lebedev had already begun this work on "Salyut-7." And now an order has come through to V. Lyakhov and A. Aleksandrov from scientists at the Leningrad Scientific Research Institute of Epidemiology and Microbiology imeni Pasteur to obtain an experimental batch of pure protein preparation from the membranes of influenza virus using the "Tavriya" device. It is needed for practical purposes. Specialists plan to use the substance obtained to design and produce highly effective molecular anti-influenza vaccines which do not have side effects and also to determine which type of influenza virus may be the agent of epidemic.

It is very expensive to obtain such a product on Earth. In orbit the whole process is simplified and, consequently, becomes cheaper. And since a small amount of pure substance is needed, in this case space production is very profitable. So V. Lyakhov and A. Aleksandrov acted as chemical shop workers in the concluding stage of their flight.

"And how do you evaluate the actions of the crew during the flight on the whole?" I ask V. Ryumin.

"The crew went through the whole stage smoothly. There were no disruptions, and no tension was perceptible in their relations wtih each other. Hence, the program was completely fulfilled."

Well, then the return of the "Protony" will be all the more joyful.

But in the meantime the crewmen have begun to gradually get used to the effect of gravity again. Of course, at first this is only with the help of the "Chibis" pneumatic vacuum suit. It makes it possible to simulate the effect of gravity on the human organism through a drop in pressure. Other medical measures are also being carried out which make landing on Earth after a long separation from the planet easier. May your landing be a soft one, "Protony!"

12,424
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COMMENTS ON LYAKHOV-ALEKSANDROV FLIGHT

Moscow PRAVDA in Russian 25 Nov 83 pp 1, 6

[Report by PRAVDA special correspondent V. Gubarev: "An Exploit of 150 Days: Cosmonauts Comment on the Flight of V. Lyakhov and A. Aleksandrov"]

[Text] How difficult, unusual and joyful the first day on Earth after a mission! It is as if the entire weight of the planet is pushing down on your body, which has been grown unaccustomed to Earth's gravity, and it is difficult to raise your head from the pillow; and you would like to get up and run about with the people who, on a cold winter's day, carefully hold against their chests the bouquets of flowers that are for you, who have just returned from far off in space... And the first sleep on Earth takes you back again on a space watch, back to the station.

"Yes," says Vladimir Lyakhov, now the station and the mission are starting to appear in dreams, while out there in orbit dreams are usually about the Earth. Before the landing I dreamed about going fishing..."

"And I about a good bath, a real Russian bath," Aleksandr Aleksandrov adds.

The doctors show the "Protony" the birch twigs that have been sent to them by the cosmonaut detachment--they know how important normal earthly joys are for those who have just returned from the starry world.

Lyakhov and Aleksandrov do not hide it: they are deliriously happy that they have honorably completed such a difficult space mission and that their exploit has been highly assessed by the party and government.

Throughout the entire 150 days of the expedition of V. Lyakhov and A. Aleksandrov, their comrades in the detachment were with them. They accompanied the "Protony" on their mission, were present at the communications sessions, helped to conduct various experiments in orbit.

When they were just a few meters above the Earth we heard the voice of the commander: "Everything is fine. Everything is OK."

And when I asked the USSR cosmonauts present in the control center to share their impressions about this space expedition, they replied: "In the last

seconds of the mission Lyakhov assessed its results accurately: 'everything is fine.'"

And so, a few interviews after the landing.

K. Feoktistov: We designers are satisfied with the crew's work. V. Lyakhov and A. Aleksandrov fully completed the scientific and technical experiments. The impression of their work is that it is very good. Crews now conduct many dozens of different experiments and studies aboard the station. Why so many? Would it not be better to restrict their numbers? The fact is that a broad search is being conducted and it is essential to determine in precisely which field man can operate most efficienctly in space and precisely what kind of work should be entrusted to him and what should be done by automatic devices...

I would compare the situation in cosmonautics, K. Feoktistov continued, to the beginning of the era of great geographical discoveries. Man went out into the oceans to discover new lands, and then afterwards he thought about how best to use the sea routes that had been opened. First the search, and then the use... The situation in modern cosmonautics is similar because crews must master a great deal of scientific apparatus and carry out various kinds of experiments. This requires years of training, and its effectiveness is tested in a real flight. Lyakhov and Aleksandrov can boldly be given an outstanding rating!

Without doubt their work with the solar batteries was the most satisfying thing both for the cosmonauts and for us. The assembly of the extra sections was the most complicated operation that we have ever completed on the orbital complexes. Lyakhov and Aleksandrov coped with it in a masterly fashion.

G. Strekalov: The spacewalk of Volodya and Sasha enabled us to see a great deal. It was the first step toward the creation of complex structures in orbit in the future. It was an example of peaceful construction in space. Whereas before a simple operation, for example the removal of a panel with scientific apparatus, was considered a success, we have now been convinced that cosmonauts are able to carry out complicated work during extravehicular activity.

V. Savinykh: Vladimir Lyakhov and Aleksandr Aleksandrov have deomnstrated how rapidly space technology is developing. They worked outside the station and I think that the time is not far off when a man will go out into open space in the morning and start to conduct various scientific observations there and then at the end of the day return to his space house. Not long ago that would have seemed fantastic, but since the flight of Lyakhov and Aleksandrov such work can be planned. I would advise the scientists to start thinking about these kinds of experiments.

A. Ivanchenkov: Five years ago I completed a 140-day mission with Vladimir Kovalenok. At that time such a long mission was unusual, but now we have become accustomed to it; these kinds of expedition have become the norm. Progress in providing scientific support from a station has been very marked. Let me cite just a few figures: about 20,000 photographs, 73 experiments with the "Astra" apparatus, a series of technological studies, dozens of electrotopograms and holograms, biological experiments with the "Oazis," "Svetoblok" and

"Biogravistat" apparatuses, an extensive program of studies of natural resources... No, it is impossible to list everything that Lyakhov and Aleksandrov accomplished during their mission. And in addition they carried out a broad international research program. Flight time was compressed, made denser. And this demands from the crew painstaking training on Earth, much more than even a few years back. The results of the expedition of Vladimir Lyakhov and Aleksandr Aleksandrov show that their entire mission, from the first stage of training to the landing, was completed in a splendid manner. I can assure you that this is not easy. The "Protony" deserve the very highest assessment for their work.

G. Grechko: It so happened that Yuriy Romanenko and I were the first to go out into open space in the new pressure suits. And it was necessary not only to check the status of the "Salyut-6" docking assembly but also test the suits. And so I know from my own experience how difficult it is to work outside the station. And how easily, I might say, they gracefully moved about and carried out complicated assembly work. The flight of Lyakhov and Aleksandrov has become a reference point, a new stage in major space construction in near-earth orbits.

The Soviet-Indian crew, G. Grechko continued, is now training intensively for a future flight. Times flies quickly by, and now we are busy on the simulators, working on the test benches and honing the scientific program for the international expedition. The successful completion of the flight by Lyakhov and Aleksandrov brings us nearer to new launches, in particular to the one we are preparing together with our colleagues from India.

... Vladimir Lyakhov and Aleksandr Aleksandrov have behind them a 150-day space watch and the first days following their return to Earth. But very soon they will have to live through their mission again in great detail with the scientists and specialists: the results of the space watch must be processed and analyzed so that new space crews will be able to continue to gain knowledge about that unknow thing with the short name--space.

9642
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TECHNIQUES AND INSTRUMENTS FOR COSMONAUT REMOTE SENSING

Moscow PRAVDA in Russian 5 Aug 83 p 3

[Article by L. Kiselevskiy, academician, BSSR Academy of Sciences and V. Kovalenok, pilot-cosmonaut, twice hero of the Soviet Union: "Peering out of Space-Salyut-7: Our Remarks"]

[Text] The character of the cosmonaut's work changes from one expedition to the next. The scientific program constantly takes on a more practical character. Many branches of the economy are awaiting the results of research and experiments carried out by cosmonauts and the flight of V. Lyakhov and A. Aleksandrov shows this very clearly. From the first days of their presence onboard "Salyut-7," they have devoted the greater part of almost every working day to the investigation of the earth's natural resources.

Remote sensing methods for investigating the natural environment make it possible to obtain extensive information on the structure and constitution of different natural and artificial objects ranging from the various sections of a field, a wood or a pasture to complete natural units and zones. This data can be processed immediately in frequent batches and it is possible to obtain a practically continuous data flow on natural resources and the composition of the environment.

Remote sensing methods have found practical applications in agriculture, forestry, ocean fisheries, geology, city planning, for the solution of land use problems and for mapping and meteorology.

Two approaches have been projected for the development of space-based spectral methods for the investigation of the earth's natural resources. These are the multizonal photographic and television recording methods which can obtain images of the underlying earth surface in several relatively narrow spectral bands, and spectrometric methods intended to record, over an assigned range, the entire spectrum averaged for a certain sector of the underlying surface. The former methods are noted for their high spatial resolution. Each approach has preferential areas of application and their prospects have been convincingly demonstrated by a series of space experiments.

Remote sensing, especially satellite-borne methods of investigation, require specific electro-optical equipment which is small-scale, dependable and suitable for computerized data processing. The Physics Institute, BSSR Academy

of Sciences, organized the development of the necessary spectral equipment and manufactured it in its experimental production section. Up to the present time, seven different spectral and spectro-polarization instruments have been produced. Some of the instruments were manufactured in small numbers in the experimental production section of the Central Design Office, BSSR Academy of Sciences, and this made it possible to equip several geological and agricultural scientific research and experimental-production organizations.

The instruments of the Physics Institute, BSSR Academy of Sciences, were successfully utilized onboard the "Salyut-4" and "Salyut-6" space stations. At the present time, the MSS-2P spectropolarimeter constructed at the Institute is being used on "Salyut-7." Testing is being completed on a fundamentally new space instrument, the SKIF spectrometer, which was developed in association with the Gagarin Cosmonaut Training Center.

Space experiments have been carried out with instruments from the Institute by many pilot-cosmonauts: G. Grechko, A. Gubarev, P. Klimuk, V. Sevast'yanov, Yu. Romanenko, V. Kovalenok, A. Ivanchenkov, V. Lyakhov, V. Ryumin, V. Savinykh, L. Popov, A. Berezovoy and V. Lebedev. They participated in the analysis and interpretation of the results. The unified efforts of scientists and astronauts significantly speed up the work and the data is enriched by the addition of visual scientific observations. We should not forget that, at the present time, pattern recognition is performed significantly better by the human eye than by instrumental systems, especially if the person is well trained.

For example, during visual observation of the ocean surface carried out from the orbiting space station "Salyut-6" during the second main expedition, areas were detected whose color differed markedly from that of the surrounding ocean. In a series of cases, it turned out that such color differences were linked to accumulations of plankton and were therefore of interest to the fishing industry. The observation method previously applied by the crew for ocean investigation was not used, and the results which were obtained turned out to be unexpected and did not agree with current concepts of ocean optics.

Attempts to explain the observed phenomenon were undertaken in several of the country's scientific centers. The Physics Institute, BSSR Academy of Sciences, successfully did so by carrying out experiments concerning the detailed spatial and spectral structure of areas associated with various aquatic objects. The research was carried out by means of small-scale high-speed spectrometers.

During the third main expedition, a combined satellite complex experiment was carried out. Three similar MSS-2MV instruments were set up onboard the "Salyut-6" space station, a laboratory-aircraft of the Cosmonaut Training Center and on a scientific research ship, and spectrometric investigation was carried out on an assigned area in the Caspian Sea.

The participants in the experiment were USSR pilot-cosmonauts L. Popov and V. Ryumin and staff members of the Physics Institute, BSSR Academy of Sciences, the All-Union Marine Fisheries and Oceanography Scientific Research Institute of the USSR Ministry of Fisheries and the Gagarin Cosmonaut Training Center.

The next subsatellite experiment had the same participants and constituted the fifth main "Salyut-6" expedition. The crew carried out measurements of Caspian region spectra by means of the MSS-2MV unit which was already in orbit with V. Savinykh. The aircraft and ship-based groups were directed by USSR pilot-cosmonaut V. Lyakhov.

Each main expedition of the orbital scientific "Salyut-6" complex involved the use of the MSS-2MV spectrometer for several geophysical experiments during which the earth's surface and atmospheric formations along the flight path were spectrometrically investigated. More than 100,000 spectrograms were recorded during these experiments.

For the further development of space methods for searching for and monitoring fishing zones, the Physics Institute, BSSR Academy of Sciences, together with the Gagarin Cosmonaut Training Center created the SKIF, a new satellite-borne optical instrument. This instrument makes it possible to carry out the initial spectral analysis onboard the satellite. The optico-mechanical instrument is portable and can be hand operated. It can thus be directed towards any object without turning the station. While the spectrometry is being carried out, the instrument photographs the object and records service data and voice comment. All instrumental operations are carried out automatically and the unit includes a movie camera and a digital magnetic recorder.

The combined publications of the pilot-cosmonauts and scientists of the Physics Institute, BSSR Academy of Sciences, show that space spectrometry can solve many problems including not only the improvement of satellite-borne methods for monitoring biological products in the world oceans, but many others as well. In particular, there are the study of the variation of optical characteristics of the station viewports, the creation of methods for measuring color characteristics of natural objects and the utilization of color data for object identification, the explanation of the nature of noctilucent clouds, research on processes of interaction of solar radiation with the natural environment, etc. The economic effect of the use of these and certain other results already amounts to more than four million rubles.

The crew of the second main expedition on "Salyut-7" is well acquainted with the work by the Belorussian scientists together with their colleagues from other republics. In preparation for the flight, V. Lyakhov and A. Aleksandrov not only studied the instrument but also participated in the establishment of research programs. This certainly aids them to work effectively and creatively in space.

12497
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## 'ASTRON' SATELLITE

Moscow ZEMLYA I VSELENNAYA in Russian No 4, Jul-Aug 83 pp 2-3

[Article by V.A. Kotel'nikov: "The 'Astron' in Orbit"]

[Text] The automatic "Astron" station was successfully put into orbit to become an artificial Earth satellite on 23 March 1983. Aboard it are a UV telescope and a complex of X-ray spectrometers for studying galactic and extragalactic sources of electromagnetic radiation.

The instrument designed for studying the UV spectrums of space objects is a double-reflecting telescope constructed on the basis of Ritchey-Chretien optics. The diameter of the primary mirror is 80 centimeters with a focal length of 8 meters for the entire system. The primary and secondary (26-centimeter diameter) hyperbolic mirrors are made from glass ceramic [sitall] with a special coating. A multichannel scanning spectrometer designed for operation within the range 1,050-3,500 Angstrom is mounted in the focal plane behind the primary mirror. Sensors that track the positions of stars on the spectrometer slit are also located there.

Ultraviolet radiation in selected parts of the electromagnetic spectrum is recorded photoelectrically. It is considered that the program that has been drawn up will make it possible to obtain information on the UV spectrums of objects such as, for example, hot stars. In particular, study of these objects may lead to an understanding of the reasons for the nonsteady-state nature of stars. Questions associated with observing the interstellar medium (determination of chemical composition, evaluation of total mass, dynamics of processes and the search for special conditions) may also be resolved with the aid of UV observations.

The resonance lines of most atoms and ions are found in the UV range. This is precisely why when studying elements with a low content of atoms or with atoms in special states, observations in the UV range are very important.

Investigation of the galaxies, in particular the nonsteady-state nature of their nuclei, is of great significance for galactic cosmogony. The enormous amounts of energy in the galactic nuclei are given off mainly in the shortwave range and this is why UV observations play a key role in this problem.

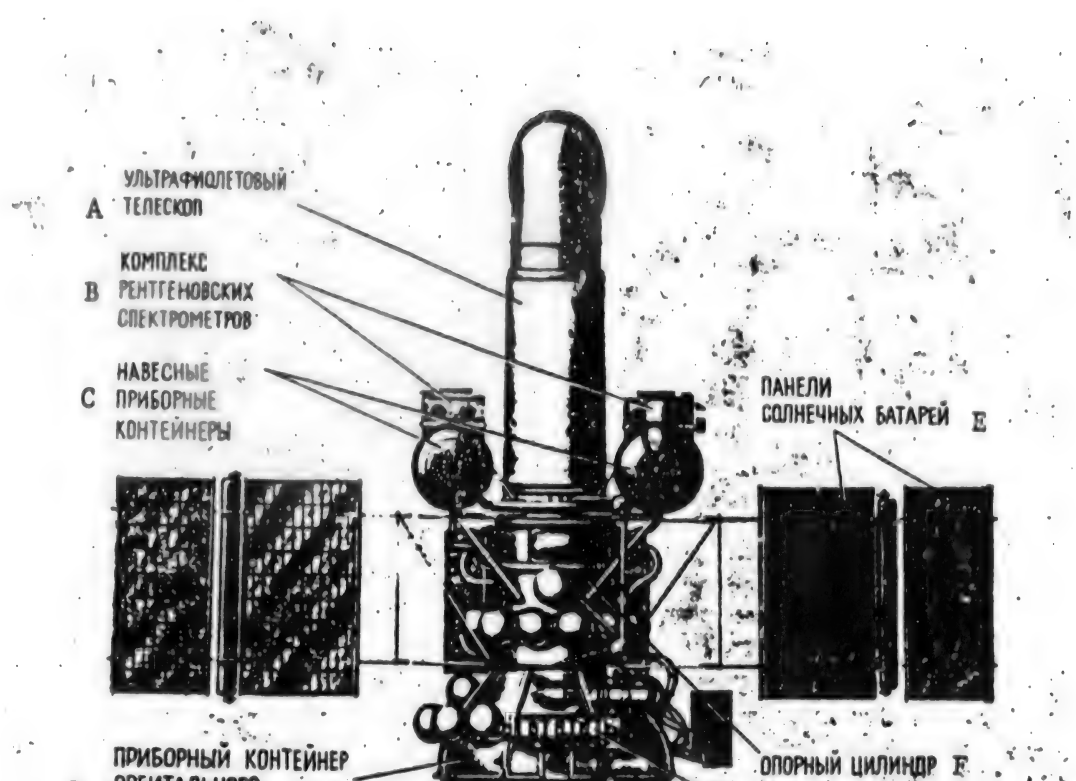


Figure 1. General View of the "Astron" Station

Key:

A. Ultraviolet telescope
B. Complex of X-ray spectrometers
C. Suspended instrument containers
D. Instrument container for orbital apparatus
E. Panels for solar batteries
F. Support cylinder
G. Astro instruments

* * * * *

A small telescope with an objective diameter of 0.2 meters and a focal length of 1 meter has been mounted in order to identify objects in the sky that are outside the tube of the main telescope. The optical axis of this instrument lies parallel to the axis of the main telescope. The field of vision is 1 X 1°. An image in the identifying part is transmitted by radio to points back on Earth.

A very elongated orbit (perigee 2,000 kilometers, apogee 200,000 kilometers) has been chosen for the station so as to eliminate the effect of high-energy particles in the radiation belts, which sharply increase photomultiplier

current, and in practice would make it impossible to conduct the experiment. In addition, since during the process of identifying the observed part of the sky ground observers participate in redirecting the telescope, the satellite must be in view for long periods.

Some time after the station has been injected into its orbit the orientation control system will bring the apparatus into a permanent solar-stellar orientation. Then, on command, the station is rotated so that the axis of the telescope is oriented on a given part of the sky. Accuracy in orientation of the axis of the apparatus in space is better than 5' and angular rate of stabilization does not exceed $5 \times 10^{-3}$ degrees per second. The station's orientation control system can maintain these kinds of parameters for several hours. After the space apparatus has been brought onto a bearing with the aid of the orientation control system, which in this case plays the role of an initial "rough" bearing circuit, a secondary "accurate" bearing circuit is switched in; this consists of sensors that track the position of a star, electronics, and the drives for the secondary mirror. In central tracking mode accuracy in stabilizing the image on the inlet slit of the spectrometer is better than 0.3" and in offset tracking mode it is better than 2". Then, on command from the logic circuit or ground control points, measurement of UV radiation from the object being studied commences (via three channels), together with radiation in the visible range (one channel). At the conclusion of an observation on a selected object the telescope is re-aimed to another part of the sky and the procedure is repeated. Measurement results can be relayed to ground reception points directly or recorded on an onboard recorder and transmitted during communications sessions with the station.

The X-ray spectrometers mounted on the sides of the UV telescope are designed for studies within the energy range 2 to 25 keV with a total collecting surface of 0.2 square meters. There are 10 spectral channels. In order to suppress background noise created by charged particles each of the two plates on which seven proportional X-ray counters and one reference counter are mounted is surrounded by a protective cover. The X-ray spectrometers can conduct measurements simultaneously with the UV telescope. In addition, it is planned to conduct synchronous observations with a network of optical telescopes on the ground.

French scientists and specialists from the Marseilles space astronomy laboratory participated in the development of a UV spectrometer for the telescope, which was developed at the Crimean Astrophysics Observatory. French specialists also worked on the design of the scanning system for the spectrometer and the electronics fo recording the spectrums, and they calibrated the spectrometer. The scientific program of observations was drawn up by scientists from both countries. The sky-recognition camera, on which specialists from the Armenian SSR Academy of Sciences worked, was also a joint development.



9642
CSO: 1866/67

RESEARCH CONTINUES WITH 'INTERCOSMOS-BOLGARIYA-1300' SATELLITE

Moscow PRAVDA in Russian 2 Sep 83 p 3

[Article by V. Adas'ko, technical director of the "Intercosmos-Bolgariya-1300" project, V. Balebanov, scientific chief of the Soviet side, and K. Serafimov, scientific chief of the Bulgarian side: "In an Orbit of Friendship. Science Extends its Horizons"]

> [Text] The "Intercosmos-Bolgariya-1300" satellite is the joint creation of Bulgarian and Soviet scientists. It is continuing its work in circumterrestrial orbit. On 7 August 1981 it was put into a near-circular polar orbit at a height of 800-900 kilometers. Designed initially for 6 months of operations, the satellite is now in the third year of its faultless watch in space.

The main purpose of the scientific program for the "Intercosmos-Bolgariya-1300" apparatus, developed jointly by Soviet and Bulgarian scientists, is to obtain data on the Earth's ionosphere and magnetosphere. In particular, provision was made for a study of the various types of movements in ionsopheric plasma and their connection with phenomena in other fields of the Earth's magnetosphere and in interplanetary space, together with the detection and recognition of irregularities in magnetospheric plasma and turbulence phenomena in the polar and middle latitudes. The program's main task is to obtain data that will help in revealing the secrets of energy transfer from the Sun to Earth in space and time.

So-called solar activity affects the status of the Earth's magnetic field and atmosphere. The "breathing" processes taking in the Sun are sensed by the animal and plant worlds. The rate of tree growth and the "flareups" in the numbers of insects, for example, the locust, and the spread of certain diseases all depend on solar activity.

The composition of the ionosphere is constantly changing under the effect of solar radiation, and this in turn also means changes in the conditions in which solar energy penetrates to the Earth's surface. Many of Nature's secrets relating to weather formation and climate are hidden in ionospheric processes.

Moreover, radio waves are not propagated in ionospheric plasma as freely as in air: they are absorbed and refracted. And these processes are directly connected with the status of the ionosphere. The study of its dynamics is helping to overcome the difficulties in insuring radio communications.

In turn, the physical processes taking place in the ionosphere are also closely linked with and largely depend on phenomena in the more distant fields of circumterrestrial space--the Earth's magnetosphere. It is necessary to measure electrical and magnetic fields and the streams of fast, charged particles in order to understand them. At the same time it is important to record the aurora borealis, caused by the penetration of these particles into the atmosphere and ionosphere. Thus, it is a question of the need for comprehensive research and the conducting of multiplane experiments. This is the kind of program that is being carried out aboard the "Intercosmos-Bolgariya-1300" satellite.

We note that this program possesses a whole range of advantages over similar, previous programs. First of all, the research was initiated during a period of enhanced solar activity and has continued against the background of a fall in this activity. The prolonged operation of the satellite has made it possible to make measurements at different times of the year, in various illumination conditions in orbit, and with the orbital plane at various positions along the line between the Sun and the Earth.

A total of 15 instruments are mounted aboard the satellite. Twelve of them, including an angular laser refelector, were made in Bulgaria. They were designed with the participation of Soviet specialists.

The height of the satellite--about 900 kilometers in a polar orbit--insures simultaneous recording of phenomena typical of both the Earth's ionosphere and its magnetosphere, along with the study of the most interesting physical processes taking place at the boundary of the polar caps.

Up to now about 800 communications sessions have been held with the satellite. Data transmitted from aboard the satellite during about 200 communications sessions has been initially processed. Valuable data have been obtained on the concentration, temperature and composition of ionospheric plasma both during relatively quiet periods and during strong geomagnetic disturbances, and this has made it possible, in particular, to trace the dynamics involved in the formation of the ionsopheric troughs in plasma concentration. The fact is that in the middle latitudes on the night side of our planet a field of low concentrations of ionospheric plasma is observed. The reason for this is the low velocity of the charged particles entering on this side and their relatively rapid neutralization. The measurements that have been made are helping in gaining a better understanding of this phenomenon. As is known, streams of plasma coming from the Sun are controlled by the global electrical and magnetic fields. The complex of equipment mounted on the satellite makes it possible to measure not only this field but also the plasma streams themselves. Simultaneous measurement of the ion composition and electron temperature offers an opportunity for evaluating the rates at which the plasma is converted into neutral gas.

It is known that in the high latitudes the fine structure of the magnetic field can be observed as the result of the passage of localized streams around the Earth's magnetic field. The distribution of these streams is being traced on the magnetograms obtained from aboard the satellite.

The new scientific results include the detection of unusually high bursts in the electrical fields and in the ions, which may be the reason that charged particles accelerate. Preliminary data from a study of anisotropic plasma, that is, irregularities in the physical properties of ions and electrons moving in various directions, also indicate the existence of acceleration effects in the electrical field. Accurate measurements of the electrical and magnetic fields have become possible thanks to the good orientation of the satellite along three axes and the steps taken to insure electromagnetic compatibility between onboard instruments and the space apparatus itself.

Among other results we note the spectrums of the aurora borealis that have been obtained. According to present ideas the aurora borealis results from the reaction of plasma streams with the upper layers of the Earth's atmosphere. It has not yet been possible to create a quiet and sufficiently hot plasma in laboratories on Earth. But in circumterrestrial space it exists constantly, and during especially powerful displays of the aurora borealis it reaches very high temperatures. Therefore, the experimental study of the aurora borealis is of interest not only for geophysicists. It will also perhaps help in conducting thermonuclear research on Earth.

Laser location and simultaneous photography of a space apparatus by ground stations in the Soviet Union, Bulgaria, the GDR, Cuba and a number of other countries has been conducted for the first time within the framework of the "Intercosmos" program. Accuracy in measurements of a satellite's position in orbit is of the order of 1-2 meters. Taking accurate measurements of the orbit with the aid of laser observations makes it possible to insure a reliable navigational "coordination" between measurements on any part of the orbit.

Of course, the success of the "Intercosmos-Bolgariya-1300" is not happenstance. Bulgarian space science approached it with solid scientific and technical knowhow. During the years that the "Intercosmos" program has been in effect, highly skilled specialists have been trained in Bulgaria and complex scientific equipment for space research and programs of space experiments has been developed. Laboratories and institutes that do work on space research have been set up.

The substantial contribution of .e Bulgarian scientists in the study of space has been helped by fraternal aid .rom the Soviet space school, all-around Soviet-Bulgarian cooperation in all spheres of life, and the creation of Bulgaria's powerful scientific and technical potential.

Soviet-Bulgarian cooperation in space research is the natural continuation of our peoples' traditional fraternal ties. They will undoubtedly develop and grow stronger with each passing year.

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UDC 551.510.535.2

LARGE-SCALE AND SMALL-SCALE MOVEMENT OF PLASMA IN UPPER IONOSPHERE FROM DATA FROM 'INTERCOSMOS-BOLGARIYA-1300' SATELLITE

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 21, No 5, Sep-Oct 83 (manuscript received 24 Feb 83) pp 697-706

DUBININ, E. M., BIKOLAYEVA, N. S., PODGORNYY, I. M., BALEBANOV, V. M., BANKOV, L., KUTIYEV, I., MARINOV, P., SERAFIMOV, K. and TODORIYEVA, L.

[Abstract] Initial results are presented from measurements conducted aboard the "Intercosmos-Bolgariya-1300" satellite of the large-scale plasma convection picture in auroral fields and also of small-scale disturbances detected at altitudes of approximately 900 km. using the ID-1 instrument to measure the velocity of ionospheric plasma. Details are given of the equipment used for the measurements and of the experimental procedure employed. Results from measurements of the components of plasma horizontal drift velocity conducted in 1981 are shown in graph form. The large-scale movement of plasma agrees well with the present scheme used for magnetospheric convection. The small-scale disturbances detected with the ID-1 instrument appear to contain plasma moving at velocities in excess of 4.5 kilometers per second with simultaneous local dips accompanying jump increases in ion drift velocity. The structure of the small-scale disturbances is discussed. Figures 5; references 31: 5 Russian, 26 Western.
[31-9642]

UDC 581.521

INVESTIGATION OF HIGH-ENERGY ELECTRON STREAMS BY 'INTERCOSMOS-BOLGARIYA-1300' SATELLITE

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 21, No 5, Sep-Oct 83 (manuscript received 13 Dec 82) pp 707-709

GAL'PER, A. M., GRACHEV, V. M., DMITRIYENKO, V. V., KIRILLOV-UGRYUMOV, V. G., POLUKHINA, N. G., ULIN, S. Ye. and CHARKOV, R. N.

[Abstract] A description is given of the "Elektron" instrument mounted on the "Intercosmos-Bolgariya-1300" satellite to conduct prolonged measurements of the high-energy electron streams detected earlier in the area of the

Brazilian anomaly by the "Salyut-6" station. A block diagram of the instrument is shown. The instrument consists of four scintillation counters, a Cerenkov gas detector and two lead filters. An anticoincidence scintillation counter covers the instrument on three sides and the Cerenkov sensor is filled with $SF_6$ gas at an atmosphere of 6 atmospheres, with a threshold relativistic factor of gamma = 11. The entire instrument measures 310 X 193 X 287 mm and weighs 10 kilograms. Power consumption is 12 volts. The instrument is mounted on the satellite so that it always lies perpendicular to the orbital plane. The instrument measures electron streams in two channels at energies of 20 to 280 MeV and 35 to 550 MeV. Results from measurements already conducted indicate that a marked longitudinal correlation exists between streams of charged particles and the maxima recorded. At altitudes of 800-900 km. in the region of the equator electron energies of 35 to 550 MeV have been recorded. Figures 3; references 6 (Russian).
[31-9642]

UDC 621.317

INITIAL RESULTS FROM MEASUREMENT OF MAGNETIC FIELD BY 'INTERCOSMOS-BOLGARIYA-1300' SATELLITE

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 21, No 5, Sep-Oct 83 (manuscript received 20 Jul 82) pp 710-717

ARSHINKOV, I. S., BOCHEV, A. V., ABADZHIYEV, N. S., ARSHINKOVA, K. I., BELEV, V. N., ZAKHARIYEVA, Ye. G., MANDIL, Yu. B., DOLGINOV, Sh. Sh., ZHUZGOV, L. N., KOSACHEVA, V. P., STRUNNIKOVA, L. V., TYURMINA, L. O., SHAROVA, V. A. and SHKOL'NIKOVA, S. I.

[Abstract] A method is shown for measuring the magnetic effects of longitudinal currents, and the large-scale and fine structure of longitudinal current systems at various latitudes and under different levels of magnetic activity are illustrated using data obtained from aboard the "Intercosmos-Bolargiya-1300" satellite employing the IMAP three-component ferromagnetic magnetometer. The metrology and experimental procedure followed are described. Magnetic disturbances observed during the experiment are shown in graph form and discussed. The measurements show that large-scale longitudinal currents can exist at any level of geomagnetic activity and have a two-layer configuration in the morning and evening sectors. Details are given of the fine structure of current movement throughout the 24-hour period. Figures 4; references 12: 2 Russian, 10 Western.
[31-9642]

UDC 523.72

COMPREHENSIVE WAVE EXPERIMENT ABOARD 'PROGNOZ-8' SATELLITE

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 21, No 5, Sep-Oct 83
(manuscript received 12 Dec 81) pp 718-724

ALEKSEVICH, Ya. N., AFANAS'YEV, Yu. V., BALEBANOV, V. M., BASKAROV, V. Ye., BOBKOV, Yu. N., BORODIN, N. F., VAYSBERG, O. L., VOYMA, Ya., GOROBEY, V. N., KARACHEVSKIY, V. N., KLIMOV, S. I., KOREPANOV, V. Ye., NAZAROV, N. I., NAMESTNIK, S. G., NOVAK, K., NOVAKEVICH, V., NOZDRACHEV, M. N., OBERTA, Ts., PEVZNER, A. M., PESOTSKIY, L. V., PORFIROV, V. P., SAVIN, S. P., SIKORSKI, Z., TIMOFEYEV, P. P., TRISKA, P. and TURCHANINOV, V. N.

[Abstract] A joint Soviet-Polish-Vzechoslovak experiment to investigate plasma processes using equipment aboard the "Prognoz-8" satellite is described. A block diagram is shown of the onboard ULF detection system used in the experiment and the operation of the equipment is explained. The specific purpose of the experiment was to study variations in plasma parameters at frequencies lower than that of ion plasma frequencies, concentrating in particular on the frequency range 0.1 to 125 hertz. Measurements were made of the spectrum of electric and magnetic fields and of the spectrum of fluctuations in the plasma stream. The operation of the detection system is described in its various configurations to conduct given measurements. Details are given of noise-suppression measures used in the experiment. Initial experimental findings indicate that maximum values for the spectral intensity of the electric field and plasma stream in the circumterrestrial shock wave are found at 1-9 hertz. Figures 5; references 12: 7 Russian, 5 Western.
[31-9642]

UDC 551.510.53

EFFECT OF VERTICAL MIGRATION ON COMPOSITION OF THERMOSPHERE DURING GEOMAGNETIC DISTURBANCES

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 21, No 5, Sep-Oct 83
(manuscript received 3 Nov 82) pp 725-730

VLASOV, M. N. and DAVYDOV, V. Ye.

[Abstract] Calculations are made of height distribution for O, $O_2$ and $N_2$ at altitudes of 90 to 200 kilometers, taking into account turbulence shift, molecular diffusion, vertical migration and a number of photochemical processes, in order to evaluate the effect of mean mass transfer on the basic model for thermospheric diffusion. The equations used in the calculation are shown and the constraints of the calculation described. Results are shown in graph form and compared with the DTM semiempirical model. Good agreement is found but change in the temperature of the thermosphere during perturbations is disregarded. Analysis shows that middle-latitude changes in the composition

of the thermosphere during geomagnetic disturbance can be modeled on the basis of consideration of the two factors of additional warming and mean mass transfer. Thus, for the first time the possibility has been demonstrated of constructing such models on the basis of multiple-component diffusion. In order to do this the rate of mean vertical mass transfer must be less than diffusion rates. It can be assumed that the same processes of mass transfer act on the composition of the thermosphere during geomagnetically quiet periods, although this supposition requires further investigation. Figures 4; references 11: 3 Russian, 8 Western.
[31-9642]

UDC 581.521.6

HIGH-ENERGY SOLAR PROTONS

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 21, No 5, Sep-Oct 83 (manuscript received 26 Nov 81) pp 731-736

VOLODICHEV, N. N.

[Abstract] Earlier studies on high-energy solar particles are described and the two-stage nature of particle acceleration during solar flares is discussed. A description is given of experiments conducted using "Prognoz"-series satellites to measure solar protons at energies greater than 100 MeV and greater than 500 MeV during solar flares, employing Cerenkov and scintillation counters. In all cases a delay was observed in the arrival of such protons on Earth compared with time of maximum intensity of the radio burst in the centimeter range and of hard X-radiation. Assuming that the two sets of protons at energies of greater than 100 MeV and greater than 500 MeV are injected simultaneously and follow the same paths to Earth, the time of injection of solar protons from the acceleration field can be determined. The data indicate that the delay can be of several minutes or several tens of minutes duration. This is demonstrated by data from seven solar flares when delayed injection occurred relative to the pulse phase of flares occurring at various dates between July 1966 and November 1977. The presence of gamma radiation in these flares is discussed and the possible mechanism of the delay is examined. All the experimental data tend to confirm the idea of a two-stage acceleration of particles during major solar flares, the first stage occurring during the explosive stage of the flare and the second at later times that vary as a function of how rapidly conditions are formed for further acceleration of particles to high energies. References 35: 13 Russian, 2 Czech, 20 Western.
[31-9642]

UDC 581.521

LOW-ENERGY PROTON FLUX IN SOLAR QUIET TIME AND DURING SOLAR ACTIVITY

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 21, No 5, Sep-Oct 83
(manuscript received 3 Mar 82) pp 803-806

ZEL'DOVICH, M. A. and LOGACHEV, Yu. I.

[Abstract] Available data on anisotropism do not confirm whether background proton flux is of solar or interplanetary origin. This problem was investigated by measuring the energy spectrums of background proton flux in the energy range up to 1 MeV during solar quiet time covering 20 cycles of solar activity. Particle intensity was determined from the time interval. Minimum background flux at energies up to 1 MeV was found to be time-correlated with the course of solar activity. The same pattern emerged when protons at energies of 0.97 to 1.85 MeV were investigated. The findings indicate the possible solar origin of proton flux at energies of about 1 MeV since intensities increase as solar activity grows. Further studies showed that increased proton intensity is not associated with increases in the velocity of the solar wind. Analysis shows that at any given velocity for the solar wind, proton intensity during quiet time is not lower than a certain given level. Hence it is concluded that the contribution from the high-temperature tail of energy distribution for protons in the solar wind in background proton flux at energies of 1 MeV can be substantial at the minimum in a cycle of solar activity. It is possible that as solar activity increases a number of additional sources of energy particles appear in the Sun, whose contribution to background flux may be great. Figures 4; references 19: 1 Russian, 18 Western. [31-9642]

UDC 551.510.535

DIFFUSION OF DOUBLE-CHARGED IONS OF ATOMIC OXYGEN IN PLASMOSPHERE IN RECOVERY PHASE FOLLOWING IONOSPHERIC STORM

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 21, No 5, Sep-Oct 83
(manuscript received 17 Feb 82) pp 806-810

AVAKYAN, S. V. and DEMINOV, M. G.

[Abstract] An attempt is made to clarify the effect of $O^{++}$ ion buildup in the near geomagnetic corona following a strong magnetic storm. Assessments were made during the period following the conclusion of a magnetic disturbance when the neutral atmosphere had virtually returned to an undisturbed state and plasma flow into the protonosphere was transsonic. It was assumed that the medium consists of neutral particles, electrons and $O^{++}$ and $H^{+}$ ions. Details are given of the input data for the calculation and the calculation is shown. The results indicate that the density of $O^{++}$ ions in the near geomagnetic corona can increase by a factor of 10 or more through the increased

flow of ionospheric protons and possibly $O^+$ ions insuring filling of plasma-depleted tubes of force in the geomagnetic field. The effect is at a maximum 1 to 2 days following magnetic disturbance. Figures 1; references 33: 11 Russian, 22 Western.
[31-9642]

UDC 533.961.2

ALTITUDES VARIATIONS IN CHARGED PARTICLE TEMPERATURE AND CONCENTRATION IN QUIET CONDITIONS

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 21, No 5, Sep-Oct 83 (manuscript received 12 Mar 82) pp 810-813

ANATI, I., AFONIN, V., BENTSE, P., BEZRUKIKH, V., SEMEREY, T. and SHYUTTE, N., Hungarian Academy of Sciences TsIFI, Budapest; USSR Academy of Sciences Institute of Space Research, Moscow; Hungarian Academy of Sciences State Technical Institute, Sopron

[Abstract] Measurements of charged particle temperature and concentration were conducted during the 25 October 1977 daytime launch of the "Vertikal'-6" geophysical rocket in order to study variation in flow and heat loss to electron gas in solar quiet time. The rocket reached an altitude of about 1,500 kilometers with less than 3° deviation from the vertical. Geophysical conditions during the launch period were as follows: number of Sun spots $R_z = 25$, radio emission $F_{10.7} = 88 \cdot 10^{-22} W/m^{-2} \cdot Hz^{-1}$, $K_p = 0$, $SigmaK_p = 8^+$, $D_{st.eq.} = -24gamma$. Measurements were made with a system of five flat electrostatic analyzers, a spherical ion trap and a Langmuir probe mounted on the rocket. Measurement results are presented as graphs showing altitude-related dependencies for concentration and temperature. Analysis of the altitude profiles shows that at approximately 200-1,200 kilometers heating of electron-ion gas is of a marked nonmonotonic nature. Considerable variation in the temperature of ion gas is observed above the F layer, evidently the result of changes in cooling processes and heating through excitation of the fine structure of atomic oxygen and ion-exchange reactions. Maximum heating corresponds to altitude where hydrogen ions became dominant. Figures 2; references 12: 1 Russian, 11 Western.
[31-9642]

## ACADEMICIAN BARSUKOV INTERVIEWED ON 'VENERA' RESULTS

Moscow IZVESTIYA in Russian 11 Oct 83 p 3

[Interview with V.L. Barsukov, corresponding member of the USSR Academy of Sciences, director of the USSR Academy of Sciences Institute of Geochemistry and Analytical Chemistry imeni V.I. Vernadskiy, by B. Konovalov: "To Venus for Earth"; date and place not specified]

[Text] [Question] Valeriy Leonidovich, a new Soviet satellite is now making its first revolutions above Venus. Tell us, please, how this planet appears today in the eyes of terrestrial science, and what sort of picture of it the scientists are seeing.

[Answer] If we could withstand the truly hellish conditions on Venus--a temperature of 500 degrees and a pressure of 90 atmospheres--and fly over this planet we would see mainly a hilly, lifeless plain above which isolated plateaus reach up, along with chains of volcanoes.

When the "Venera-4" went off on its mission--the first probe in history to conduct direct studies in the atmosphere of this planet--the designers placed on it a special sack of sugar for the antenna. Their idea was that it would be dissolved in water after the landing and thus deploy the antenna. That was in 1967 when it was thought that the surface of Venus was probably continuous ocean. This now seems naive. Thanks in general to cosmonautics and radar our ideas about the Solar system have been altered radically. Earth has turned out to be a unique planet. Only Earth has a world ocean and the origin and existence of life associated with it.

If there was an ocean on Venus at one time--and this possibility cannot be excluded--then the hilly valleys and the lowlands and depressions were the ocean bed, and the mountainous areas the islands and continents. The equatorial belt of Venus has now been mainly studied. The polar regions remain for us "terro incognita." We do not know with accuracy what lies north of the 70th parallel on Venus or south of the 60th parallel. Now, thanks to "Venera-15" the situation is changing; we shall be able to study the north polar region. In the part of Venus already studied the mountainous areas occupy only about eight percent of the surface. Three mountain masses might be called continents--Aphrodite Terra, Ishtar Terra, and in the very south a small part of Lada Terra have been studied; the latter is evidently a hot analog of our cold terrestrial Antarctic.

The Ishar Terra in the southern hemisphere, so-named after the mother of the gods in ancient Babylon, is of the greatest interest from the geological standpoint. In contrast to Aphrodite Terra, which gradually becomes hilly valleys, Ishtar Terra rises about 10 kilometers above them in a steep, arc-shaped ledge. In terms of size Ishtar Terra is comparable to our Australia. The high Maxwell Montes, rising about 8 kilometers above the surrounding plateau, are located there. And if we take the entire gradient from the Venusian lowlands to the topmost peaks, the height is about 13 kilometers--higher than Everest. An enormous ring-shaped crater 100 kilometers across is located at the top of the largest mountain, just like volcanoes on Earth.

Chains of mountains can be traced on Ishtar Terra running parallel to each other, like the Cordilleras or the Himalayas on Earth. They skirt the major mountain plateau of Lakshmi, which is about the size of Tibet. And this entire mountain system reminds one of Tibet and the Himalayas. It is still unclear how the mountain chains on Venus were formed. It would certainly have required some kind of powerful horizontal compaction forces. On Earth the occurrence of mountain chains is explained by the displacement of the individual plates of the Earth's crust. On Venus, the planet's crust is evidently much thicker than on Earth, and horizontal shift is difficult. Obviously the mountains there occurred through some other mechanism. It is most likely that on Venus volcanic activity and vertical movement of the blocks of the lithosphere played a larger role.

[Question] What results from the preceding "Venera-13" and "Venera-14" stations were, in your opinion, the most interesting?

[Answer] Thanks to the drilling and subsequent analysis of samples conducted by the Soviet space robots, Earth science for the first time obtained a complete chemical analysis of rock from the Venusian surface in two different areas. By comparing the data with information obtained previously on the content of potassium, uranium and thorium at several points on the Venusian surface we can now get an idea of the most widespread types of rock on the planet. These turned out to be rocks of the basalt series with a high potassium content on the most ancient surface. And since by studying Venus we are, as it were, making a journey into the past of our own planet, this result is important for an understanding of the Earth's development. There were evidently periods in the history of our own planet when an intensive effluence of potassium from the depths was taking place. This fact raises the question of the correctness of our ideas about the initial conditions of the Earth's mantle and the mechanism that formed the "nucleus" of the continents. Now, taking into account the data from comparative planetology, new models are being developed for the Earth's formation and its entire subsequent geological history leading to the formation of the terrestrial crust. This work is of both fundamental and practical significance because the formation of more than 80 percent of mineral reserves was associated with the most ancient periods of life on our planet.

The color panoramas in the landing areas, transmitted by the "Venera-13" and "Venera-14" stations, were of enormous interest for scientists. The stratifications of a fine material can be clearly seen on one of the panoramas. This most

probably indicates the volcanic origin of such structures. The fine material is typical of volcanic ash ejected into the atmosphere during eruptions and then settling on the surface. This happens repeatedly and in this way a stratified structure is formed.

Rock formations also appear on the panoramas that externally are very similar to the volcanic bombs seen on Earth. All this forcibly leads to the thought that Venus is a tectonically active planet.

[Question] Studies of the Moon and the planets of the solar system have now been conducted for almost a quarter of a century. What do you consider the most interesting results in comparative planetology, which has undergone rapid development thanks to these studies?

[Answer] Perhaps the most substantial result obtained through comparative planetological analysis is the realization of the exceptional importance of the role of planetary bombardment from outside during the very early stages of their existence. The numerous craters of impact origin found on the Moon and on Mars, Venus, Mercury and other planets indicate that bombardment was particularly intensive at one time. There is no reason to suppose that this process was taking place less intensively on Earth than, say, on the Moon. Rather the contrary, because Earth is larger and it attracts material more strongly from surrounding space.

Up to now the history of the Earth has been regarded as a cyclic evolutionary development of geological processes. It is now becoming clear that at the stage when the formation of the planet had been completed, that is, when it was about 500 million years old, intensive bombardment by celestial bodies played a colossal role. The impact of large celestial bodies of asteroid size would have led inevitably to very strong local heating, the degree of which depended on the nature of the impact on the surface and the mass and velocity of the "newcomers." We can see on the Moon the kind of local sites that virtually flowed together and formed a melted outer zone with the planetary body from which the initial crust was formed. This process undoubtedly also took place on Earth. But previously geologists did not understand this and were unable to imagine that the intensive bombardment would give rise to a surface ocean magma in which the processes of material transfer and the separation of materials and crystallization took place.

This new knowledge is forcing us to reexamine the theory on the formation and development of our planet and is of fundamental significance. And every flight to the other planets is helping to establish the new view of the history of our own Earth.

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CSO: 1866/32

DESIGN MODIFICATIONS ON 'VENERA-15, -16'

Moscow IZVESTIYA in Russian 21 Oct 83 p 3

[Article by IZVESTIYA scientific observer B. Konovalov: "Radar Above the Incandescent Planet"]

[Text] On the screen of the video recorder the enigmatic surface of Venus appeared rather prosaic. Light and dark slanting lines lay between two black vertical lines, looking somewhat like a school exercise book. But each millimeter of the image hid new information invaluable for terrestrial science. For the scientists this sight was more intriguing than a detective novel. For the first time in history the radar aboard the "Venera-15" was making it possible to obtain an image of the north polar region on this distant planet--a region that terrestrial science knew nothing about with certainty.

"The station is flying above the hilly plains that cover almost three-fourths of the planet's surface." Corresponding member of the USSR Academy of Sciences V.L. Barsukov, a well-known Soviet geochemist, is doing a commentary for the journalists on the pictures being transmitted from Venus. "The north pole lies across 200 kilometers. The clear black band that has now appeared is a narrow canyon about 2 kilometers wide and more than 100 kilometers long. And there is a crater obviously of impact origin. Its central peak can be clearly seen. Look, there is no shadow behind the bright white band. That means that here there is a sharp scarp many kilometers high separating the lowland from the continental field. There you are... the white bands are beginning to grow wider and ramify--that is a mountain chain skirting a wide plateau, like the Himalayas round Tibet. We are looking at one of the Venusian continents--Ishtar Terra. Up to now it has been thought that it was about the size of Australia, but now we know that it is at least twice as big. The study of the world of Venus is extraordinarily important for an understanding of our own planet's past. We do not know exactly how the continents arose or how Earth's mountain systems were formed, and comparison of the planets may throw light on their origin."

The conversation is taking place at the experimental base of the Moscow Energy Institute special design bureau at the "Medvezh'i ozera" tracking station in one of the numerous rooms located beneath the giant cupola of the 64-meter antenna. The entire installation at the receiving station where we are is higher than a 20-storey building. But this is only one "component" of the Soviet Venus-Earth radio bridge.

The "Venera-15" and "Venera-16" satellites have been revolving about the planet for days, Earth time. When they approach most closely to the planet the scientific studies start, and the information collected is then transmitted to Earth. The orbit has been selected in such a way that on the approach the radar is sideways on at an angle of about 10 degrees to the vertical, thus facing the planet all the time. It looks, as it were, through three slits, one directly ahead and the others slightly to the left and the right. Subsequently three pictures arrive on Earth, separated by vertical bands. This enhances the reliability of the experiment. For 20 minutes in each session Venus "rotated" beneath the satellite to such an extent that it is possible to see a strip of its surface 9,000 kilometers long and 150 kilometers wide.

"The 'Venera-15' radar has already been checked. Now it is the turn of the 'Venera-16,'" corresponding member of the USSR Academy of Sciences A. Bogomolov told the journalists. "Each square millimeter of the image received is a section of the Venusian surface measuring 1 X 1 kilometers. We can now distinguish on the planet's surface details 1 or 2 kilometers in size. That is about the same kind of resolution that is obtained in studies of the Moon from Earth using a telescope. We can therefore compile maps of Venus dozens of times more accurate than existing maps and, what is most important, draw a map of the north polar regions, which science has not yet studied. We intend to study territory covering a total area of 60 million kilometers. The work will take a long time..."

The preparations for the "Venera-83" expedition took many years. A second-generation "Venera" design was used in the development of the Venusian cartographers. This series was started by the "Venera-9" which transmitted to Earth the first panoramas of the surface of our celestial neighbor. It was decided to replace the "head" of the station--it would have a radar instead of the spherical descent apparatus.

But it was impossible mechanically to carry out this operation. The new tasks required considerable changes in the station design, decision schemes and control logic. Any change in the station, even a small one, causes a real "chain reaction" of alterations. And this was a major replacement!

The stations developed for the "Venera-83" expedition differ substantially from their predecessors. Injection of the Venusian satellite into the selected orbit required an increase in the fuel reserve. Accordingly, the fuel tanks were made more than a meter longer.

This time the data flow from the station is much greater than previously. The station must operate not for a couple of hours but for a prolonged period. The high-directional parabolic antenna via which communications are maintained with Earth was made larger; its diameter is almost a meter greater. Transmitter power was also boosted. The large antennas of the "Medvezh'i ozera" and Long-Distance Space Communications Center are being used to receive the signals on Earth. As a result of all these measures, the throughput of the Venus-Earth radio link has been increased by a factor of about 30; 100,000 data bits per second can now be transmitted.

The wing area of the solar batteries has been almost doubled and their power correspondingly in order to insure the power supply for the onboard radar.

But, of course, the replacement of the descent apparatus with the radar caused the greatest difficulties. An antenna 1.4 meters across and 6 meters long was chosen for it. But the diameter of the descent apparatus was only half that. This meant that the antenna had to be folded. But it turned out that even the folded antenna would not fit into to old nosecone fairing of the carrier rocket. It had to be made longer.

Much effort went into development of the "heart" of the research complex--the side-looking radar, which was designated "Polyus V." The latest achievements of radar, radioelectronics, computer technology and modern electronics technology were used in its development. The apparatus was based on integrated microcircuits and is very compact.

A special, sealed compartment was designed to locate the new service and scientific apparatus on the station.

In short, many changes were made. And each individual instrument, unit, and part of the station, and the whole station in its entirety underwent ultracritical and comprehensive testing. Particularly careful checks were made of the antenna for the onboard radar, whose radio waves must pierce the shroud of the cloud cover and make a detailed study of the Venusian surface. Despite its 6-meter length, the scanning antenna must be sufficiently rigid: its surface must retain its shape with an accuracy of several millimeters even under the most severe conditions.

Before the stations were launched an enormous amount of preparatory work was done on Earth. Using up-to-date computers in laboratories on Earth they simulated the conditions in which the radar was to operate in the future on Venus. Mathematical models altered the numerous variants of the planet's reflecting surface. Venusian operating conditions were created on test benches. Now these conditions have become real for the Soviet stations.

At "Medvezh'i ozera" they showed us the double of the Venus radar. Its 6-meter antenna, folded and slightly tapered at the ends, looks rather like a Venetian gondola. And on its sides, like two rocker arms, the antennas of the radar altimeter (capable of measuring the height of the relief with an accuracy of 50 meters) and the radiometer, which makes it possible to obtain a heat map of Venus. This "trimaran," now sailing close to a distant planet, is revealing its surface to the gaze of terrestrial science.

9642
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DEVELOPMENT OF 'VENERA-15, -16' RADARS

Moscow PRAVDA in Russian 21 Oct 83 p 3

[Article by V. Gubarev: "The Pole of Venus"]

[Excerpt] "Venera-15 and 16" show a family resemblance to previous stations in the way they are constructed. But because they have specific missions, the work on them demanded essentially new solutions from the designers, engineers and workers at the spacecraft factory.

"'Venera-15 and 16' underwent a complete cycle of ground trials," relates one of the stations' creators. "Where in the previous ships the landing system was located, there now is a set of scientific equipment, especially the side-scanning radar units. Two antennas are located in the forward part. The size of the solar batteries was increased, a system of precise astro-orientation was installed, a new telemetry line was required to provide a ten-fold increase in the volume of data relayed to earth, more fuel was required for the ships' work in orbit, etc. I am describing several changes in the 'Venera-15 and 16' stations just to show you that they were essentially new designs for us and therefore required a full cycle of preparation for launch and work in space as though we were dealing with totally new spacecraft. That is the way we approached these space stations. The guidance system required special attention since the radar equipment can function only with precise orbital insertion of the spacecraft around Venus.

It is necessary to orient the stations with precise accuracy at the time of survey. 'Venera-15' flies in an orbital attitude that allows its solar batteries to be directed at the sun. In preparing to survey, the spacecraft begins to maneuver at a critically determined time, turning to assure effective functioning of the side-looking radar units."

Today when the first photographs have been made of Venus' north pole, we can say that the creators of the space stations have managed their jobs brilliantly. But the real heros have turned out to be those who designed the radar units. After all, it is the radar that enabled us to see the invisible.

The word "invisible" is no exaggeration: scientists were able to overcome Venus' cloud layer, penetrate it and actually see the planet's surface with "the naked eye."

It was not long ago that such a mission seemed impossible. Many scientists thought that photographs of the surface could be obtained only from a landing craft that had made a soft landing on the planet. The "photo-eye" is incapable of seeing from a great distance, and the dense atmosphere shows up as frosted glass, with nothing visible behind it.

The name Mstislav Vsevolodovich Keldysh comes to mind again. It was he who demanded that the designers and scientists devise a way to have a look at Venus.

The most unlikely projects came into being. It was even suggested that a Venus airplane be built from which photographs could be taken of the surface. But experts in optics showed that such a plane would have to fly at most a kilometer above the surface, thus making global survey impossible.

The idea was considered of putting a TV camera on a landing craft and turning it on during the descent. But it was calculated that the atmosphere of Venus would prevent good results and that the descent velocity would be too great.

Keldysh, however, stubbornly insisted on his idea. He not only pleaded and persuaded but, above all, he attracted the country's top scientists to the Venus research program.

Academician V. A. Kotelnikov was interested in Venus since the Institute of Radio Engineering and Electronics which he directs had not only taken part in many space experiments but made radar observations of Venus and other planets. The work there had been going on regularly since 1961.

A. F. Bogomolov, corresponding member of USSR Academy of Science, is known as a top expert in radio engineering and has been connected with space research since the first earth satellite.

The president of the Academy of Sciences appealled specifically to the teams directed by these scientists. They well understood how complex the problem was that faced them. Radar units are of course notable for their great size. And the accuracy of their work depends primarily o their magnitude. Even aviation radar units are huge in comparison with those used in space.

The side-looking radar units installed in "Venera-15 and -16" are essentially a new stage in the development of radio engineering. They assist in carrying out the survey in the following way. Radio waves are sent out at an angle to the surface and "illuminate" it, so to speak. The reflected signal is picked up by a receiver and transmitted to earth. Since the radar beams encounter various surfaces along the way--mountains, depressions, elevations, canyons--the returning signals are different. With the assistance of highly complicated ground technology and with computers playing the major role, the signals are analyzed and transformed into images. On board, there is a radar altimeter that assists in obtaining a profile of altitudes. Using a special method, a "synthesis" of the image emerges, and we are able to see the invisible on a photograph... This is simply an outline, of course. The system of equipment used to carry out the present survey of Venus' surface is extremely complex.

It includes not only the on-board portion but an extensive ground center for processing the data. And when we say that Soviet scientists are the first to photograph the surface of the planet, this is to say that--both on earth and around Venus--the highly complex systems are performing flawlessly and richly deserve the tribute "first in the world."

The trial sessions of surveys of the north pole of Venus were a success. Now the routine work begins: the future cells for sustained contact with the stations in order to receive and process the data they send.

It will not be long at all before space technology will enable us to compile photographic maps of the entire surface of Venus and we will have a faithful global representation of Venus, a planet about which we have only a vague idea so far. Today marks the beginning of an age of great discoveries about the geography of the morning star.

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FIRST IMAGERY FROM 'VENERA-15, -16' SHOWN

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[Article by A. Pokrovskiy, with TASS photograph (not included) showing a radar image of the Venusian surface: "Look Through the Clouds--'VENERA-15 and -16': Our Commentary"]

[Text] I have on my office desk a long, narrow photograph. It shows a tiny strip of the Venusian surface hitherto unseen by the human eye. Workers of they OKB [Experimental Design Bureau] of the Moscow Power Institute [MEI] gave the photograph to me about a month ago in the Medvezh'i Ozera settlement. They were having a happy day at the time--Genuine proof had been received that the equipment they had created, with the aid of colleagues from the USSR Academy of Sciences Radio Engineering and Electronics Institute [IRE], was working reliably and stable reception of the signals being transmitted by it was in progress on earth.

Actually, the capability of modern technology to transmit information about distant worlds across tens of millions of kilometers of outer space is astounding. But, to tell the truth, the photograph itself did not make a great impression on a non-specialist. "It didn't register," as they say in such cases.

"What do you want?" Doctor of Physical-Mathematical Sciences O. Rzhiga asked in explanation later. "This, you know, is a trial, a test photograph. The regular work of 'Venera-15 and -16' will be started in a few days. The signals recorded at the Long-Range Space Communications Center will be forwarded to IRE, and there they will undergo special processing in a complex of equipment including electronic computers. This complex will accomplish the operation performed by our eyes, or the lens of a camera, upon receipt of optical images. The extent to which the operation is time-consuming and laborious may be understood from a single figure--about eight hours are required for the processing of a photograph, even with the aid of the high-performance processor developed jointly with the Institute of Electronic Control Machines of Minpribor [the Ministry of Instrument Making, Automation Equipment and Control Systems]."

And on 15 November a group of journalists was invited to the USSR Academy of Sciences Presidium to view processed Venusian photographs in the proper manner.

"What has necessitated the surveys of Venus now being conducted?" Academician V. Kotel'nikov, vice president of the USSR Academy of Sciences and director of IRE, asked the meeting beforehand in a brief opening address. "As you know, we have been studying our celestial neighbor for a relatively long time. However, we have not hitherto obtained a detailed picture of its surface. And this is necessary in order to understand the evolution of planets of the solar system and to attempt, on that basis, to reconstruct the past and foretell the future of our planet--earth.

"Indeed, let us recall certain stages in the 20-year history of the study of Venus with the aid of space vehicles. In 1967 the landing module of the interplanetary station 'Venera-4' entered the atmosphere of the planet for the first time and conducted measurements of its chemical composition and the distribution of temperatures and pressures. Three years later the landing module of 'Venera-7' transmitted data to earth directly from the surface of the planet for 20 minutes. It was established then that the temperature on the surface was about 470 degrees Celsius, and the pressure 90 atmospheres. Subsequently, 'Venera-8' measured solar illumination intensity during descent in the atmosphere of our celestial neighbor. It was discovered that the cloud layer ends at an altitude of 35 kilometers above the suface, and below that level the atmosphere is clear. The intensity of illumination on the surface of Venus is approximately that of an overcast day on earth, which is sufficient for telephotography.

"New landing modules devised by Soviet designers thus were intended to conduct telephotography and scientific research on the surface of Venus. In 1975 the first views of the Venusian surface, transmitted by the landing modules of interplanetary stations 'Venera-9 and -10', spread throughout the world. And 7 years thereafter, 'Venera-13 and -14' transmitted color pictures of the surface. A truly unique experiment was conducted at that time: Collection of Venusian soil and analysis of its chemical composition.

"In result, specialists acquired the means to draw a detailed picture of physical conditions existing on the surface, in the atmosphere, and in the near-planetary space of Venus. And yet, we don't have the customary geographical map of it, although such maps of the Moon, Mars and even Mercury have been created.

"A similar geographical map of Venus is essential, for example in investigating the planet's climate, atmospheric circulation and the structure of its gravitational field. It would permit the application of data obtained at the landing sites of landing modules to other regions of the planet.

"Paradoxically at first glance, the situation is explained by the optical opacity of the atmosphere of Venus, which precludes direct photography of the plant's surface from the orbit of an artificial satellite. But the atmosphere of Venus is transparent to radio waves, and that fact has afforded the opportunity to use radar and radio astronomy technology for studying the planet's surface.

"As is well known, the USSR Academy of Sciences IRE, jointly with a group of institutions of other agencies, set up at the Distant Space Communications

Center, as early as 1961, a radar installation for conducting regular radar observations of Venus and the other planets. Data about scattering of radio waves by the surface of Venus, in particular, were obtained. Experience in processing the reflected signals then was exploited in developing the complex of equipment being used in the present experiment.

"For that purpose, so-called side-looking radar units, an innovation even for terrestrial conditions, were developed. The essence of the method is that a sector of the surface at an angle of 10 degrees to the side of the flight path is 'illuminated' with radio waves by means of a transmitter and antenna, for then unambiguous separation of reflected signals is possible. Under such conditions spatial resolution is 1.5-2 kilometers. In other words, in contrast with the previous experiments, it is possible to see rather fine details of the surface. The reflected signals enter the receiver, are recorded in a memory unit, and thereafter are transmitted for processing on earth."

So that's what it's like, this mysterious Venus! It is as if you were looking at it entirely unhindered from on board an orbital ship--an impression familiar to many from the photographs and television pictures of our earth obtained from the "Salyut" station. Similar terrestrial analogies were present, as well, in the commentaries of V. Barsukov, corresponding member of the USSR Academy of Sciences and director of the Institute of Geochemistry and Analytical Chemistry of the academy. On the film of a photograph which had captured a strip of the Venusian surface 150 kilometers wide and about 7,000 kilometers long, he directed attention to the journalists to mountain ranges, high mountain plateaus, valleys and rifts.

"Isn't it true that the mountains are similar to our Himalayas or Alps? And right there is a locality reminiscent of certain parts of central Asia. Direct your attention to the crater--it's entirely like the famous Arizona crater in the U.S.A. Alongside--a basaltic lake like those which also occur on the moon. Here are the imprints of powerful external blows, also exactly as on the moon. Sometimes traces of volcanic activity, hardened lava flows, are plainly visible."

Such comparison is not accidental. Specialists turn to terrestrial analogies not at all because terms for designating formations on our celestial neighbors have not yet been invented. The truth of the matter is that such bodies are not simply neighbors: The planets of the solar system are members of a single family, and thus one may speak of a definite commonness of their biographies.

"Comparative planetology is a relatively young science," said V. Barsukov in closing his commentaries, "but it is developing precipitately, providing more and more information to meet the needs of geology. And just now we see how it has taken a new step forward--One may say that study of natural models of the mechanisms of mountain formation, crustal folding and other processes very important for understanding the evolution of the earth has become accessible."

And so, strip after strip, the Soviet vehicles "Venera-15 and -16" are phtographing the Northern Hemisphere of "the morning star", which never before was accessible to the human eye. Thus its map soon will be created?

"Not so very soon," explain the specialists. "So far we have obtained only photographs, and it is necessary to measure the altitudes of relief elements. To this end, radar altimeters and contour analyzers have been installed on the Venus satellites. But, whereas the radar units operate on the side-looking principle, the altimeter makes measurements in a straight line. Accordingly, again with the aid of electronic computer technology, it is necessary to coordinate these data with each other."

...Envoys of earth, cartographers, are flying over Venus. They fly under the strict control of a complicated system of astral orientation, for at each instant they must act according to an assigned program, accurately advising their coordinates. What kind of map is without coordinates! But there will be a map.

PHOTO CAPTION

1. p 3. In the photograph: A radar image of the surface of Venus obtained by space vehicles "Venera-15 and -16". TASS Photo.

12319
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FOURIER SPECTROMETRY RESEARCH ON 'VENERA-15, -16'

Moscow PRAVDA in Russian 17 Dec 84 p 3

[Article under the rubric "Our Commentary: 'Venera 15 and 16'" by V. Moroz, department director of the Institute of Space Research of the USSR Academy of Sciences, doctor of physico-mathematical sciences, professor, and V. Linkin, laboratory director, candidate of technical sciences, Moscow: "A 'Thermometer' for the Morning Star"]

[Text] At present two artificial satellites are operating in orbits around Venus. Both of these spacecraft were created primarily to map the surface of our heavenly neighbor with the help of radar. But the Venera 15 and 16 program of scientific investigations includes another important task: remote probing of the atmosphere. This is accomplished by two methods--infrared spectrometry and radar illumination.

The first of these was devised jointly by scientists from the USSR and the GDR. The initial discussion of it took place eight years ago when a small group from the GDR headed by Dr. F. Kempe presented to the Institute of Space Research of the USSR Academy of Sciences the following question: Should not the device created in the GDR for the study of the Earth's atmosphere be used also for the study of Venus's atmosphere? The subject was an infrared spectrometer with recording of the spectrum by the Fourier transform method, or, as it is called for short, a Fourier spectrometer.

The proposal was received enthusiastically, and the long joint effort began within the framework of the "Intercosmos" program. In the Institute of Space Research of the USSR Academy of Sciences the tasks of the new experiment and the equipment requirements were formulated. It was clear that it could not be a simple repetition of the first version, which was done for meteorological satellites of the Earth. Consequently a new device was created.

It was developed under the direction of Dr. D. Ertel by the efforts of several scientific institutions of the GDR Academy of Sciences. Foremost among these was the Institute of Space Research, which worked closely for many years with its Soviet counterpart. Several models of the device were sent to the USSR, and here our specialists invested a great deal of work in testing them in conjunction with the space vehicle.

Now Soviet specialists are receiving information and carrying on the initial processing. All the scientific data obtained in the course of the experiment

will be placed at the disposal of scientists of both nations. In the GDR up to that time there had been no specialists in the study of the planets. But a group of scientists studying the Earth's atmosphere decided to apply its experience to interpretation of the data that will be received on Venera-15 and -16, and it has been actively preparing itself for this work for the last several years. It has carried out part of the preliminary calculations necessary for the quantitative analysis of the results of the experiment, having divided this work up with Soviet scientists.

Now a few words about the Fourier spectrometer itself. Usually when a spectrum is mentioned we picture a band of color similar to a rainbow. There is nothing like this in the case of a Fourier spectometer. Its heart is a system of mirrors in which the beam of light being studied is separated into two. At first they follow different paths, but then they come together. One of the mirrors of the device moves, changing the intensity of the combined beam and drawing a curve that is called an interferogram. Its mathematical transform permits evaluation of the spectrum of the radiation being studied. In the infrared band of wavelengths this ingenious method provides the opportunity to investigate much fainter radiation and in a broader band than with an ordinary spectrometer with a prism or a diffraction grating.

However, this advantage is bought dearly: the moving parts of the Fourier spectrometer and its control system must work with an accuracy as high as tenths of the wavelength. Especially complicated problems arise in the case of the work of a Fourier spectrometer on board a spacecraft: the device must withstand the acceleration and vibration on launch and maintain its accuracy during the flight. All these difficulties were brilliantly surmounted by our colleagues from the GDR. The device they created is a record holder in sensitivity and reliability.

And now on 12 October the first series of measurements of Venus's infrared radiation was conducted. Soon the first spectra appeared on the scientists' desks. What are they and what can we expect from the analysis of them? They are curves and table of numbers that show the spectral composition of Venus's thermal radiation at wavelengths of from 6 to 35 micrometers.

When we speak of the "thermal" radiaiton of a planet, we have in mind that according to the laws of physics any body having a temperature above absolute zero radiates electromagnetic waves. And the wavelengths at which the maximum radiation occurs and the nature of its full flow depend on the temperature.

In analyzing the spectra, we are, as it were, feeling the planet's atmosphere with a probe--from its high levels to the cloud layer. Thus it is possible to create an altitude-temperature curve in the approximate range of 65 to 95 kilometers above the surface of Venus. There will be very many such temperature profiles: each series of measurements conducted daily gives from 30 to 60 spectra. They refer to points on the planet located approximately on one meridian but at different latitudes. On the following day the sounding proceeds along another meridian with altered conditions of solar illumination.

We will note that the temperature characterizing Venus's radiation into outer space are significantly lower than on its surface, which is heated to 460

degrees Celsius. This is the result of the greenhouse effect, which is caused by the fact that the Sun's radiation passes fairly well through to the bottom of the planet's atmosphere, but then the reflected infrared radiation just barely "squeezes" through it. All the characteristics of the spectrum of the radiation are formed in the poorly studied so-called "middle" atmosphere, which in this case is precisely the subject of the investigation.

And so, in the infrared experiment on Venera-15 and -16 a tremendous amount of information will be obtained concerning the temperatures above the planet's cloud layer, and the temperature fields at various levels will be studied. And they are directly connected with the characteristics of the atmospheric circulation, with the picture of the movement of the winds, which it is impossible to measure in this region of the atmosphere. But their velocities and directions can be calculated on the basis of data concerning the temperature fields. The results of the calculations will be of great interest, because the atmospheric circulation on Venus is absolutely fantastic.

For example, at an altitude of 40 to 70 kilometers a wind blows from west to east with a velocity of 100 meters per second, 50 times faster than the rotation of the planet. This phenomenon is called super-rotation. On it are superimposed other, slower and more complex motions. Several hypotheses have been put forward concerning the causes of super-rotation, but so far we do not have a clear understanding of its nature. It is interesting that strong winds blowing in a latitudinal direction have been detected in the upper layers of the Earth's atmosphere as well. One can hope that the results of the infrared experiment on the new Veneras will help to claify the problem of superrotation.

Another important objective is to determine the content of certain components in the clouds and in the atmosphere above them. Spectra already received reveal bands of sulfuric acid, of which the Venusian clouds are composed. Also visible are absorption bands of water vapor. From them it is possible to conclude that the water vapor content above the clouds is very small--from one ten-thousandth to one thousandth of a percent. Experiments conducted previously on descent vehicles have shown that in the lower atmosphere there is very little water vapor (hundredths and thousandths of a percent). Venus is an astonishingly dry planet, and this remains one of its still unexplained secrets.

Venus's cloud layer in the zone of its upper boundary was long considered to be highly uniform. Observations in in the infrared spectrum conducted several years ago revealed that this is not entirely true. The north pole of the planet is surrounded by a relatively cold ring of clouds, within which is located a warmer, dumbbell-shaped formation. It will be interesting to ascertain whether this puzzling picture has survived and to compare it with the features of the spectrum. It must be mentioned that spectral studies of the thermal radiation of Venus from on board an artificial satellite of the planet are being conducted for the first time. Previously measurements were made in certain bands of wavelengths separated by filters.

In conclusion I would like to emphasize that the infrared experiment on Venera 15 and 16 has demonstrated the broad opportunities for international

cooperation in the study of the universe. It permits using the most advanced scientific and technical achievements, combining the experience of scientists and whole teams from different countries and obtaining new and interesting results in the most economical manner.

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ANALYSIS OF DIFFUSION PROCESSES IN DAYTIME IONOSPHERE OF VENUS FROM DATA ON RADIO BLACKOUTS ON 'VENERA-9' AND 'VENERA-10' SATELLITES

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 21, No 5, Sep-Oct 83 (manuscript received 2 Feb 82) pp 737-745

GAVRIK, A. L., SAVICH, N. A. and SAMOZNAYEV, L. N.

[Abstract] A study is made of conditions that shape the daytime ionosphere of Venus across the entire range of altitudes from the lower boundary to the ionopause, considering only photochemical processes and vertical diffusion. Analysis is done by comparing calculated and experimental altitude profiles of electron concentration at various zenith angles for the Sun. The formation of Venus' daytime ionosphere taking into account photochemical and diffusion processes is calculated by determining the concentrations of ions and electrons, assuming that the most important photochemical reactions involve atomic oxygen O, molecular oxygen $O_2$ and carbon $CO_2$. The equations are shown and the details of the calculation described. Calculated results are compared with data from two-frequency radio emission from the "Venera-9" and "Venera-10" stations at various zenith angles. An upper maximum electron concentration is found at a height of 190 kilometers at low zenith angles. The rapid drop in electron concentration in the upper daytime ionosphere at zenith angles less than 63° results from the marked plasma temperature gradients. At heights between 200 and 250 kilometers electron temperature rises from $10^3$K to $10^4$K. At heights from 400 to 600 kilometers and zenith angle greater than 70° electron temperature rises more slowly but still reaches values of $10^4$K near the ionopause. Figures 4; references 24: 8 Russian, 16 Western.
[31-9642]

UDC 523.72:523.42

DOMINANT SOURCE OF IONIZATION IN MAIN MAXIMUM OF NIGHT IONOSPHERE OF VENUS

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 21, No 5, Sep-Oct 83 (manuscript received 13 Jul 82) pp 746-757

GRINGAUZ, K. I., VERIGIN, M. I., BREUS, T. K. and SHVACHUNOVA, L. A.

[Abstract] Earlier work investigating the main source of ionization creating the upper maximum electron concentration in the nighttime ionosphere of Venus

is reviewed and new ideas favoring the hypothesis that electron flux constitutes the main source of ionization are offered on the basis of data from the "Venera-9" and "Venera-10" stations. The variability of ionizing electron flux is discussed and it is shown that data on this variability do not refute the idea that electron flux is the main source of ionization. The correlation between superhot electron flux and ion concentration in the ionosphere is examined as a second argument in favor of the hypothesis. Model calculations are compared with experimental data on the vertical profiles of concentrations of the individual ion components in the nighttime ionosphere of Venus. It is argued that the idea of the transfer of oxygen ions from the daytime ionosphere to the nighttime ionosphere proposed by some researchers is an unsound hypothesis. Figures 2; references 33: 11 Russian, 22 Western.
[31-9642]

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CALCULATION OF VLF THUNDER FIELDS ON VENUS

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 21, No 5, Sep-Oct 83
(manuscript received 22 Mar 82) pp 758-764

BRYUKHOVETSKIY, A. S.

[Abstract] Proceeding from earlier work by Ksanfomaliti explaining results from the "Groza" experiment conducted to investigate the propagation of radio waves during lightning discharges on Venus, a calculation is made of VLF thunder fields in radial approximation suitable for relatively short tracks. A determination is made of the trajectories of rays and their angle of emergence and angle of impact, and also of angles of incidence on the surface of the planet and ionosphere. The surface is modeled as an impedance surface. A determination is then made of the reflection factors from these surfaces and of amplitude and phase for each ray for the case of vertical and horizontal dipoles. A calculation is made of the strength of the magnetic field in the wave and of the magnetic flux through a unit area. Calculations results are compared with the results of measurements made by the "Venera-11" and "Venera-12" descent modules. Figures 3; references 8: 7 Russian, 1 Western.
[31-9642]

UDC 523.6

DEVELOPMENT OF STRUCTURE OF NUCLEI OF COMETS IN OBSERVED CHARACTERISTICS OF COMETS

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 21, No 5, Sep-Oct 83
(manuscript received 18 Jan 83) pp 765-784

DAVYDOV, V. D.

[Abstract] The model for the nuclei of comets proposed by Whipple in 1950 has failed to lead to a clear understanding of the observed characteristics of

dozens of comets. A new approach to the problem is suggested based on the idea of a nucleus in the form of a group of bodies orbiting each other. A possible genetic structure for the nuclei of periodic comets is proposed, postulating a nucleus-swarm. The specific nature of collision of the main fragments in such a comet nucleus-swarm is considered. Flare activity and its interpretation is discussed in the context of coma formation without the participation of solar rays, and it is pointed out that the sharply increased sublimation activity in some comets could result from impact reaction between sufficiently large fragments in a group nucleus. The reason why comet nuclei split and the disappearance of comets is discussed. The external manifestation of axial rotation and swarm-centered orbital movement of fragments in a group comet nucleus is considered. An analysis is made of the quantitative relationships between the characteristics of a 2-component comet nucleus at the evolutionary stage of almost tangential collisions. A description is given of the distinguishing characteristics of a comet nucleus having a group structure. References 21: 11 Russian, 10 Western.
[31-9642]

UDC 523.43:551.571.7

## MODELING VERTICAL DISTRIBUTION OF WATER IN MARTIAN ATMOSPHERE

Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 17, No 3, Jul-Sep 83
(manuscript received 22 Oct 82) pp 144-152

KULIKOV, Yu. N. and RYKHLETSKIY, M. V., Institute of Applied Mathematics imeni M. V. Keldysh, USSR Academy of Sciences, Moscow

[Abstract] A model is proposed for determining the vertical distribution of condensate and water vapor in the lower atmosphere of Mars, taking into account the basic processes of mass transfer and $H_2O$ condensation and evaporation kinetics, and also turbulent diffusion and gravitational settling of condensate particles. Theoretical calculaitons are compared with direct and remote observation data obtained by the "Mars-5," "Mars-6," "Viking-1" and "Viking-2" probes. Using the model it is shown that for the middle latitudes in the summer hemisphere the theoretical values for optical thickness in the aerosol layer formed by water ice particles having a radius of 1.5 micrometers match observation data when the coefficient of turbulent diffusion at altitudes of 20-30 km does not exceed $3.10^5$ per $cm^2.c^{-1}$. Water ice clouds with marked optical thickness are unlikely to form at altitudes above 40 km in a dust-free atmosphere. Condensate layers forming at 50-70 km during the development of global dust storms are evidently associated with the experimentally recorded temperature increase in the stratosphere resulting from increased opacity to solar thermal radiation. For mean summer atmospheric temperatures, water vapor pressure above the $H_2O$ condensate layer can exceed the pressure of saturated vapor by about one order of magnitude, while the relative volume of $H_2O$ water vapor reaches $10^{-5}$, which value significantly exceeds those found using earlier models of the Martian atmosphere. Figures 4; references 25: 6 Russian, 19 Western.
[56-9642]

UDC 523.43:523.164.3

RADIOMETRIC IRREGULARITY OF MARS IN MILLIMETER WAVELENGTH RANGE

Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 17, No 3, Jul-Sep 83
(manuscript received 30 Jun 81, after revision 11 Mar 83) pp 153-159

KUZ'MIN, S. O. and LOSOVSKIY, B. Ya., Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences; USSR Academy of Sciences Scientific Council on Problems of Radioastronomy

[Abstract] A study is made of radiometric irregularities of Mars using data obtained with the RT-22 22-meter telescope at the Physics Institute imeni P. N. Lebedev at a wavelength of 0.8 cm during the period 1969-1977. All results are compared with similar observations conducted with the 46-meter telescope at the Algonquin Radio Observatory at a wavelength of 2.8 cm during the period 1975-1978. Details of observation conditions are described and theoretical considerations explained. Measurement results are shown and plotted graphically for comparison with theoretical values. Regardless of wavelength or the method to process results, the presence of fields of high and low radiobrightness is indicated. Fields of high radiotemperatures are located in the equatorial region in the region of the Tharsis Ridge ($l_p$ about 100°) and the Iapygia uplands ($l_p$ about 300°). Fields of low radiotemperature correspond to the Amazonian plain ($l_p$ = 160=180°) and the Central gulf ($l_p$ = 0°). Results are interpreted on the basis of the thermal emission model and it is concluded that north-south hemispheric asymmetry probably exists. The conclusions agree qualitatively with the earlier Algonquin observations. Figures 3; references 13: 8 Russian, 5 Western.
[56-9642]

UDC 528.926:774:523.035.312.2

EXPERIENCE IN IMAGE-TO-ANALOGUE CONVERSION OF LUNAR IMAGES. PART II. DEGREE OF POLARIZATION

Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 17, No 3, Jul-Sep 83
(manuscript received 17 Dec 81, after revision 2 Dec 82) pp 160-166

NOVIKOV, V. V. and POPOV, A. P., State Astronomical Institute imeni P. K. Shternberg

[Abstract] A method is described for improving sequential exposure methods to determine more accurately the parameters of polarization in images of the lunar surface for the compilation of polarimetric maps. The method is based on image-to-analogue conversion in order to obtain polarimetric images from polarized pictures of the Moon. Material used in experimental work included data obtained with the AZT-2 telescope at the State Astronomical Institute imeni P. K. Shternberg and the AZT-8 at the Kharkov State University. Polarimetric images were constructed using the algorithm derived by Yu. V. Koriyenko

et al. A system of isopolars was constructed from the polarimetric sections at the same scale as the map, together with a coordinate grid for libration on the same scale, and one was superimposed on the other to produce a sequential superposition with the initial lunar images, using visible details with known selenographic coordinates. At the scale used, error in superposition was 0.5 mm. Values for the degree of polarization were compared with photo-electric measurements and error was found to be less than 2 percent. The method enables automation of traditional, laborious methods for obtaining colorimetric and polarimetric images and accuracy is significantly improved. Although the method is less flexible than digital methods it does permit measurements with spatial resolution close to that of the original photographs. Figures 2; references 20: 17 Russian, 3 Western.
[56-9642]

UDC 523.042:523.42

DEVELOPMENT OF INTERPRETATION METHOD FOR CHROMATOGRAMS OF VENUSIAN ATMOSPHERE OBTAINED BY 'SIGMA' CHROMATOGRAPH ABOARD 'VENERA-12' AUTOMATIC INTERPLANETARY STATION

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 21, No 5, Sep-Oct 83 (manuscript received 22 Feb 82) pp 813-814

GEL'MAN, B. G., MUKHIN, L. M., NENAROKOV, D. F., OKHOTNIKOV, B. P. and ROTIN, V. A.

[Abstract] Interpretation of chromatograms obtained aboard the "Venera-12" station with the aid of the "Sigma" chromatograph is discussed. Although the purity of the detector is well described by the Platzman equation, if the carrier gas is contaminated an increase of several percent occurs in detector background current and the calibration curve for the detector may contain anomalies in the form of negative signal in the detection threshold field. These anomalies have been found for materials with high ionization potentials ($H_2$, $N_2$, Ar), and in a less pronounced way for oxygen. This led to error in peaks for argon and oxygen. Since the anomalies are associated with the degree of contamination of the carrier gas it was possible to reproduce the conditions leading to the anomalous peaks and clarify the nature of the contamination found in the "Sigma." Calibration curves are shown for Ar and $N_2$ in the anomaly field. Using these data it was possible to reproduce the parameters of the Venusian atmosphere and show that the concentration of atmospheric argon is $0.010 \pm 0.003\%$. Figures 1; references 4 (Russian).
[31-9642]

UDC 612.014

# EFFECT OF WEIGHTLESSNESS ON ALTERED CELL MORPHOLOGY IN MICROSPOROGENESIS IN TRADESCANTIA PALUDOSA IN EXPERIMENTS ABOARD 'VOSTOK-3, -4, -5, -6', 'VOSKHOD-1' AND 'COSMOS-110, -368'

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 21, No 5, Sep-Oct 83
(manuscript received 8 Jan 82) pp 785-791

DELONE, N. L., ANTIPOV, V. V. and DAVYDOV, B. I.

[Abstract] Experiments to evaluate the effect of spaceflight factors on cell morphology are described. The subject selected was microspores of Tradescantia paludosa. Experiments conducted aboard the "Cosmos-110" and "Cosmos-368" employed plants whose roots remained on Earth. In experiments aboard the "Vostok" series (-3, -4, -5 and -6) and the "Voskhod-1", sections of stalk with racemes were used. The experimental procedures are described. The duration of the space experiments varied between 3 and 22 days. Parallel experiments were conducted simultaneously on Earth. Subjects exposed to the effect of spaceflight were found to contain various kinds of morphologic cell changes. The cell types distinguished included giant, mononuclear, binuclear and multinucleate cells and small cells. Tuberosities were seen on many cells, particularly the mononuclear cells. Mitotic aberrations are illustrated and detailed in table form. The findings are discussed within the context of genetic regulatory mechanisms and it is concluded that the cellular changes found in the subjects resulted largely if not entirely from the effects of weightlessness alone (effects associated with the launch and landing are discounted). On the basis of the experimental findings it is not considered necessary to protect cosmonauts from the effects of weightlessness on the genetic apparatus since the duration of the mitotic cycle in this subject is exceptional and in any event the cellular changes seen are the normal response of plants. Figures 1; references 10: 6 Russian, 4 Western.
[31-9642]

# FORECASTING SATELLITE MOTION

Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 5, May 83 pp 44-45

[Answer to readers' questions by Candidate of Engineering Sciences Yuriy Alekseyevich Luk'yanov: "Forecasting Satellite Motion"]

[Text] Readers S. Taranykha, V. Kovalevskiy and others ask how a satellite's orbit and a spacecraft's orbital lifetime are computed, and why, they write, do some satellites burn up in the atmosphere while the flight of others is brought to an end. The editorial board asked Candidate of Engineering Sciences Yu. Puk'yanov to answer these questions.

[Question] Yuriy Alekseyevich, since the question that touches on computing the orbit of a satellite is a general one, I would like to begin with that.

[Answer] First of all it must be said that, under the influence of a large number of factors, in time the orbit of a satellite changes its shape, dimensions and position in space. Figuratively speaking, it lives the way a person does--it changes irreversibly with age. Calculating it ahead of time for a prescribed interval also is complicated, like the forecasting of a society's economic development. Whole books of a specialized literature have been written about this portion of the theory of flight. In my answer I will be able to speak about what is most important, and only in the most general form.

The motion of a spacecraft can be described by a system of differential equations of the sixth order. Therefore, for unambiguous determination of an orbit of its flight, it suffices to know six independent paramaters or initial conditions of its motion. They can be, for example, the satellite's coordinates and the speed of their change at a definite moment in time. In practice, these tracking-and-control complex data ordinarily are used: distance from the measuring point to the spacecraft, the speed of its change, and the angular position and speed of the satellite relative to certain axes. The six initial conditions are found by means of definite mathematical dependencies between the orbital elements and the results of measurements. More often, not six, but fewer parameters, are found, but then they are measured not at one but at several measuring points. Moreover, in order to reduce the effect of possible errors, an effort is made to obtain as large a number of measurements of each parameter as possible. Definite methods exist for

processing information from an abundance of measurements, enabling more reliable results to be obtained for each concrete case.

[Question] What can be said about the lifetime of an artificial earth satellite?

[Answer] In theory, a satellite's orbital life is understood to be the period of time that a so-called critical orbit is achieved--during which the craft can maintain still another revolution. But how to find it? This question is fairly complicated both in a theoretical and a practical regard.

A spacecraft introduced into earth orbit will, in the final analysis, return to earth again. In so doing, two variants are possible: either purposeful braking by means of an engine installation and the landing of a re-entry vehicle in a prescribed region, or a spontaneous descent under the influence of the atmosphere, which, in the final analysis, leads to cessation of its existence. But in both cases communications with the craft are interrupted during entry into the atmosphere's dense layers.

[Question] When does this occur?

[Answer] In the existing literature, the notion of an upper limit of the dense layers of the atmosphere is not strictly defined. Experience indicates that it is at an altitude of 110-150 kilometers and it depends considerably upon the spacecraft's ballistic coefficient and fluctuations in the atmosphere's density. Thus, the less the weight of the craft or the greater the area of its lateral cross-section, the more rapidly its life ends. Moreover, the altitude of entry into the atmosphere's dense layers depends upon the orbit's shape and orientation. The concept of a point of entry into the dense layers of the atmosphere basically could be determined also as the moment, for example, that a certain overload or flight altitude is reached. But this overlooks conditionality, since each type of satellite has its own.

[Question] And how is the impact point of a satellite forecast?

[Answer] The nonuniformity of the aerodynamic effects and the nonidentical strength and heat resistance of the various structural elements lead to the satellite's ceasing to exist at heights below 80 kilometers, when overloads reach the maximum. It breaks up into a number of fragments which, during their fall, remind one of meteors. The major portions of them burn up completely in the atmosphere. It is still rare that the mass information media report that the remains of some spacecraft or other has fallen on the earth. Thus it was, for example, during the descent of the American Skylab station and the Cosmos-954 satellite.

We have already spoken about the difficulty of determining the point of entry of a spacecraft into the dense layers of the atmosphere. Suffice it to say that an error here of 1 minute yields a deviation of 450 kilometers between the impact point and the computed point. That is why, during these most important moments, practically all the active and passive means that lie along the flight track are devoted to tracking the satellite.

[Question] This means that errors are the main culprit in the difficulties of forecasting. Tell us about them, please, in greater detail.

[Answer] Errors in models of the atmosphere exert the greatest influence on precision in forecasting the position of a satellite over short intervals. Experience indicates that there is a discrepancy between the actual altitude profile of its density and the model. These deviations can be allowed for by refining the satellite's ballistic coefficient in accordance with the results of processing the orbital measurements. However, this potential exists only within a narrow range of altitudes and only during observation of a portion of the flight.

Still another source of error is in the measurement of aerodynamic characteristics, particularly the drag coefficient of tumbling satellites because of unforeseen changes of their attitude relative to the approach flow. For some of them this coefficient can change severalfold. Let us note that the use of modern models when forecasting the motion of any spacecraft at an interval of more than a day enables its ballistic existence to be determined with a precision of 15-20 percent.

[Question] And what are the ways for increasing forecasting precision?

[Answer] Scientists see two basic directions here. The first consists in refining models of the atmosphere and in developing methods for forecasting variations of its density, which are determined by solar and geomagnetic activity over short intervals. The second is in developing a model of the uncontrollable motion at low altitudes in order to determine and account for the aerodynamic characteristics of a satellite during the final stage of flight.



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CSO: 1866/142

UDC 629.7

## OPTIMAL CONTROL OF ROTATION FOR SPACE APPARATUS OF VARIABLE MASS

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 21, No 5, Sep-Oct 83
(manuscript received 26 Apr 82) pp 659-665

GRIGOR'YEV, K. G. and IOSLOVICH, I. V.

[Abstract] An investigation is made of the effect of inertia on the control of a space vehicle, using as an example the variational problem of minimum mass rate during the process of slowing the rotation of a space vehicle. The controlled rotational movement of a dynamically symmetric space vehicle about its center of mass is considered for the case of rotation effected using three pairs of adjustable thrusters of limited thrust mounted in a fixed position in the body of the space vehicle and developing torque along the main central axes of inertia. The mathematical apparatus used to solve this problem is described and it is shown that the moments of inertia change as the mass rate alters. The effect of this change on optimal control is considered. Figures 3; references 11 (Russian).
[31-9642]

UDC 629.015

## OPTIMAL CORRECTION OF ORBITAL PARAMETERS FOR SPACE VEHICLE USING LOW-POWER THRUSTER

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 21, No 5, Sep-Oct 83
(manuscript received 10 May 82) pp 666-675

YURIN, V. V.

[Abstract] A study is made of optimal rapid correction of the three orbital elements of semimajor axis, eccentricity and argument of pericenter, using a low-power thruster. The case of constant reactive acceleration is considered and constraints on the direction of acceleration are established. Equations for the movement of the space vehicle are shown and the problem of optimal rapid plane orbit correction is solved. It is shown that the structure of the equations for solving this orbit correction problem should take account of two working zones whose centers are located at an angle to the eccentric

anomaly. The variation problem for optimal rapid plane orbital transfer is considered. Analysis of the solution shows that one typical property of optimal rapid orbit correction is that the location of the working zones relative to the ascending node of the orbit remains unaltered for the entire trajectory. An algorithm is derived to describe the movement of a space vehicle using a low-power thruster, taking into account the fact that small perturbation forces can lead to significant deviations from calculated trajectory. An analysis is made of the effect of the Earth's gravitational field on the features of orbit transfer. An approximation method that does not require machine computations is shown for determining correction time. Figures 4; references 7: 6 Russian, 1 Western.
[31-9642]

UDC 629.7

OPTIMAL STABILIZATION OF STATIONARY MOVEMENT AND REORIENTATION FOR SPACE VEHICLE USING PRESSURE FORCE OF LIGHT

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 21, No 5, Sep-Oct 83 (manuscript received 16 Feb 82) pp 675-684

BLINOV, A. P.

[Abstract] The problem of optimal stabilization of stationary movement in a space vehicle using light pressure forces is considered for the case of a space vehicle with a triaxial central ellipsoid of inertia relative to center of mass, maintained on station by light pressure forces in the vicinity of a colinear point of libration in the Sun-Earth system in accordance with the algorithm derived by Luk'yanov modified by further constraints to take into account other parameters of the space vehicle's movement. Equations are shown for the movement of a space vehicle in plane orbit movement around the Earth. A description is given of the external variable configuration required for such a space vehicle in order to create control moments using light pressure forces. The problem of stabilizing the space vehicle in a minimum time interval using light pressure forces is examined. The case of an uncontrolled oscillating space vehicle is also considered. Figures 3; references 7 (Russia ).
[31-9642]

UDC 629.78

AVERAGED AERODYNAMIC CHARACTERISTICS OF ARTIFICAL EARTH SATELLITE

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 21, No 5, Sep-Oct 83 (manuscript received 7 Jul 81) pp 685-689

YANSHIN, A. M.

[Abstract] The method of Cook for describing the averaged aerodynamic characteristics of very simple solids of revolution in hyperthermal approximation is developed to take account of the reaction of the free-stream flow of

rarefied gas with the surface of a satellite, and a more general approximation of aerodynamic coefficients is given, taking into account rotation and the daily changes in the effect of the upper atmosphere, for which expressions are shown. Orbital focal parameter, eccentricity, inclination, ascending node, argument of perigee and true anomaly are taken into account. Aerodynamic characteristics are approximated for an averaged value for the coefficient of drag of the satellite, and the calculations take into consideration supersonic gas flow, supersonic free-molecular flow, the effect of light on the body and the flow of rarefied gas, given intermediate streamlining. The effect of satellite orientation on drag is also considered. Figures 2; references 8: 7 Russian, 1 Western.
[31-9642]

UDC 629.78.015

METHOD FOR DETERMINING ACTUAL ORIENTATION OF 'INTERCOSMOS-BOLGARIYA-1300' ARTIFICIAL EARTH SATELLITE

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 21, No 5, Sep-Oct 83 (manuscript received 17 Nov 82) pp 690-696

PIVOVAROV, M. L. and EL'YASBERG, P. Ye.

[Abstract] Algorithms are shown for use for determining the actual orientation of the "Intercosmos-Bolgariya-1300" satellite for the cases of local determination of orientation, and determination of orientation taking into account the readings on the angular velocity sensor. Results are shown from initial modeling done to clarify the correctness of linearizing the kinematic equations, measurement equations and approximation calculation of integrals. The approximations of relative angular velocities differ only 0.01° from the accurate results. The algorithms have been used in about 30 telemetry sessions with the satellite and the values obtained for the orientation angles were within nominal limits. Errors in calculations were largely the result of inaccurate readings on the orientation sensors. A graph of two sequential sets of results is shown. Figures 4; references 3 (Russian).
[31-9642]

UDC 629.7

PROBLEM OF RAPID ROTATION OF SATELLITE LOCATED AT A TRIGONAL POINT OF LIBRATION

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 21, No 5, Sep-Oct 83 (manuscript received 17 Mar 82) pp 794-797

MARKOV, Yu. G.

[Abstract] Rotational movement of a triaxial satellite relative to center of mass is considered, assuming that the center of mass is located at a trigonal

point of libration constrained by the three-body problem. It is assumed that $M_o$ and $M_1$ are material points or bodies with a spherical distribution of mass $m_o$ and $m_1$ respectively and are rotating about a common center of mass in Keplerian circular orbits. The satellite is regarded as a solid body. An OXYZ system of coordinates is used starting at the center of mass O whose OY and OX axes lie in the plane of the orbit while the OX axis points toward the pericenter of the orbit. The argument of the calculation is shown and perturbation movement is described. The mathematical working of the problem is shown. References 5: 4 Russian, 1 Western.
[31-9642]

UDC 629.015

METHOD FOR AUTOMATIC REFINEMENT OF MOVEMENT PARAMETERS FOR ORBITAL SPACE VEHICLE

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 21, No 5, Sep-Oct 83 (manuscript received 15 Nov 80) pp 798-802

OGARKOV, V. I.

[Abstract] In contrast to the usual methods for determining the movement parameters of a space vehicle from measurements of the altitude of flight above the planet and the height of the stars above the planet's horizon, nominal and normal equations are obtained by using finitie formulas that describe the movement of a space vehicle in almost circular orbit. The mathematical apparatus is described and contraints are detailed, and the problem is worked. Mathematical modeling of the solution of a navigational problem was done using as input data the actual movement of the space vehicle relative to which the measurements were modeled, with movement equations including eight harmonics of expansion for the gravitational potential using a standard model of the Earth's atmosphere. The calculations made it possible to analyze optimal schemes for measurement and derive a simple algorithm for automatic refinement of the movement parameters of a space vehicle in the Earth's gravitational field. Figures 1; references 4 (Russian).
[31-9642]

SPACE APPLICATIONS

## BENEFITS FROM SATELLITE PROGRAMS CITED

Moscow IZVESTIYA in Russian 1 Sep 83 p 3

[Article by IZVESTIYA scientific observer B. Konovalov: "Satellites Are Serving People"]

> [Text] More than 1,500 satellites have now been launched by our country. I would like to know what specific advantages they offer and whether the cost of their development has been recouped.
>
> (signed) B. Yershov, assembly worker, Leningrad.

Today, satellites are not serving only science. They have become an inseparable part of the national economy. There is virtually no sector for which to some degree or other space research has not been useful. More than 8,000 organizations in our country now use space information in order to solve scientific and production tasks.

One of the first practical applications of space equipment here was in the development of communications. The launch in 1965 of the "Molniya" satellite offered an opportunity for creating a space system to organize telephone and telegraph communications and transmit the programs of Central Television via space. By the time of the 50th anniversary of Soviet power the first 20 earth stations of the "Orbita" system had been built and the number of television viewers able to watch Central Television's First Program had risen by 20 million.

Thanks to the additions made to the ground lines by the "Molniya," "Raduga," "Ekran" and "Gorizont" communications satellites the programs of Central Television's First Program can now be watched by more than 85 percent of our country's population. Along with expansion of the earth points in the "Orbita" system, rapid development is taking place in the development of a network of relatively simple and cheap receiving stations for Central Television via the geostationary "Ekran" satellites, whose range covers about 40 percent of the country's territory. Receiving stations in the "Ekran" system can be located in village communications sections and rayon communications centers that serve adjacent territories, and also in geological and survey parties working in sparsely populated areas. They are also being successfully used on our ships in the icebreaker fleet.

The "Moskva" system has been developed for those places in the country that remain outside the zone serviced by the "Ekran" satellites. This system uses multipurpose "Gorizont" communications satellites. The receiving station for the "Moskva" system, operating as part of the ground relay system, is simple, requires a relatively small 2.5-meter antenna, and does not need constant attendance. The "Ekran" and "Moskva" systems will soon make it possible for the entire population of the Soviet Union to watch Central Television programs. If only regular ground radio relay and cable lines had been used the task would have been resolved only after a period of several decades. It can be boldly stated that without the satellites, from both the technical and the economic viewpoints the organization of communications for the entire country would have been simply impossible. The specialists' calculations show that east of the Urals the satellite lines are three times as cheap as radio relay lines. Their development rates are dozens of times faster and at the same time enormous material and labor resources are being saved.

The commercial "Intersputnik" space system developed on the initiative of the socialist states is playing a major role in the organization of international "radio bridges" and has already shown its great effectiveness.

Communications satellites have acquired yet another profession. Photocopies of the central newspapers are transmitted via these communication channels to Khabarovsk, Irkutsk, Krasnoyarsk, Kemerovo, Arkhangel'sk, Ashkhabad and other cities. This network is being constantly expanded, and in the future all the oblast publishing houses will receive photocopies of the central newspapers via special antennas mounted on the roofs of buildings.

Since 1967 the "Meteor" space meteorological system has been operating in the Soviet Union. It consists of satellites and regional earth centers for receiving data in Moscow, Novosibirsk and Khabarovsk. Since 1975 second-generation "Meteor-2" weather satellites have been launched regularly; these are rather more advanced than their predecessors. Making observations of about 20 percent of the world on each orbital revolution round the planet, the weather satellite gathers a hundred times more data than that provided by all the earth stations during the same period of time. The weather satellites survey our planet twice every day, including the stretches of the world's oceans and uninhabited regions where there are no weather stations at all.

The "Meteor-2" satellites can transmit directly to Earth along their line of flight. This enables all organs interested in weather forecasting, in particular those at airports and on large oceangoing ships, to see the actual weather situation for thousands of miles around immediately with the aid of relatively cheap equipment.

No weather forecast today can get by without space data. The use of this information makes it possible to save R500 million to R700 million each year in the national economy of the USSR.

The experimental "Meteor-Priroda" apparatuses, from which data is used in various sectors of the national economy, were developed on the basis of the weather satellites by Soviet industry. Equipment installed aboard them for

studies of natural resources are distinguished by their great resolution, or, in other words, their ability to distinguish "details" as small as hundreds or even tens of meters in size.

Photography of the Earth's surface from aboard these satellites (one of them has been in operation since 1980) is done in four spectral ranges. Each is best suited to solving particular problems. Thus, within the visible, near-infrared and infrared ranges it is easy to pick out melting ice from normal ice. This is very important for predicting debacle on rivers and lakes and for the piloting of ships in the Arctic. In the appropriate range of yellow light, pollution on the ocean surface and in coastal regions and rivers, and also industrial pollution, can be seen well. The blue and green parts of the spectrum are convenient for tracking plant cover, determining the condition of forests and fields, and revealing buildups of phytoplankton in the world oceans--the unique kind of "fish pastures."

Information from space is now currently disseminated to 25 ministries and administrations by the Scientific Research Center for Environmental and Natural Resources Studies of the USSR State Committee for Hydrometeorology and Environmental Monitoring.

In addition, photography in the interests of the national economy is done from aboard the "Cosmos" series satellites. The photographs are passed to the "Priroda" state center under the USSR Council of Ministers Main Administration for Geodesy and Cartography for processing, and then on to interested departments.

A regular service for monitoring our country's natural resources is gradually being created in the Soviet Union. Already this work is producing a saving worth hundreds of millions of rubles. In the opinion of specialists, in the future the savings from studies of natural resources from space could amount to R12 to R17 for every ruble spent.

Space monitoring of major sectors like forestry and agriculture is of particularly great significance. Thus, space pictures processed in accordance with special programs used in high-speed computers make it possible to compile essential maps of forest over enormous areas and to update them with any required degree of periodicity (and not every 10 years, as is done now). This provides an opportunity for monitoring the country's forestry reserves, objectively monitoring logging work, and noting parching of forest areas at the very earliest stage (this is usually associated with attacks by pests).

Satellite information has turned out to be of extraordinary value in prospecting for minerals.

Space photography has radically altered the geologists' ideas about many regions of our country. Checks on geological predictions made on the basis of space cartography in the Transbaykal and Kazakhstan, on the Kola Peninsula and on the littoral of the Sea of Okhotsk have shown their correctness and effectiveness. This enables the geologists to save time and concentrate equipment, finances and personnel on the most important and urgent directions. Space-photography geological maps of all the territory of the Soviet Union have been compiled and they are being constantly updated and improved.

Space information is of the utmost importance for comprehensive development of given regions. According to "Priroda" state center figures, by using space information (including photographs taken by cosmonauts) it is possible to make a general assessment of the natural and economic potential of a territory covering several hundred thousand square kilometers three times as fast as with the use of traditional methods. And the cost will be 12 to 15 times less.

Satellites are of extraordinary importance for studying the stretches of the world's oceans and for helping sailors. Navigation satellites (such as, for example, the "Cosmos-1000") make it possible to determine the position of a ship with great accuracy at any moment, regardless of weather conditions. It fully satisfies the requirements of shipping movements in the open sea and in individual straits. This is very important, because each year navigational errors are responsible for annual losses averaging 1 million tons of the total tonnage of ships in the world merchant fleet. This results most frequently from accidents occuring because of ships going aground in shallow waters.

Satellite navigation is significantly improving the fleet's commercial indicators. According to Soviet and foreign figures, each freighter using satellites for navigation saves an average of R19,000 annually. On fishing ships, satellite navigation offers a substantial additional effect by bringing the ships accurately to the predicted areas that are rich and through the uninterrupted determination of a ship's position in a rich fishing ground.

The practical use of satellites for reliable, round-the-clock ship-to-shore and ship-to-ship communications is now being successfully developed. The USSR Ministry of the Maritime Fleet All-Union "Morsvyaz'sputnik" association is being set up specially to solve this problem. Provision has been made for special communications channels for the maritime fleet on the Soviet "Gorizont" geostationary satellites. Soviet equipment is making it possible to insure telephone, telegraph and facsimile communications to ships via satellites. In addition, our country is participating actively in the International Organization for Maritime Satellite Communications.

Experience in the operation of satellite communications stations aboard freighters shows that thanks to the faster decisionmaking in managing the fleet, up to one percent of sailing time for ships is saved. The selection of optimal routes on the basis of current weather predictions and the state of the sea saves another 2 percent on sailing time. Specialists have calculated that for a ship with a cargo capacity of 20,000 tons the total saving from the use of communications satellites is R35,000 to R45,000 each year.

Even for the modern large-tonnage ships the sea remains a threatening element. According to figures from Lloyds of London, about 350 ships are now lost at sea each year. Many do not even manage to send distress signals but disappear without trace. Testing of the international "COSPAS-SARSAT" system is now being done in order to organize a worldwide rescue service for ships and aircraft in distress.

On 30 June 1982 the Soviet Union launched the "Cosmos-1383" satellite on which apparatus designed to fix the position of ships and aircraft in distress was

installed for the first time. On 24 March 1983 another satellite--the Cosmos-1447"--was added to the system, and then the first American space apparatus in the "COSPAS-SARSAT" system was launched. Practice has shown that this system enables operational reception of signals from distress buoys during emergencies, and to determine with a high degree of accuracy the location of a disaster. Thanks to the "Cosmos-1383" alone the lives of 40 people have already been saved.

Many satellites in the "Cosmos" series serve as a test site for developing equipment which then takes it working place aboard the series satellites. The present stage in the development of space research is typified by the use of individual satellites to create permanent systems, not only Soviet systems but also international systems.

9642
CSO: 1866/3

UDC 553.061.11:629.78

METHOD FOR QUANTITATIVE EVALUATION OF GEOLOGICAL EFFECTIVENESS IN INTERPRETATION OF SPACE IMAGES FOR PREDICTING MINERALIZATION

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 6, Nov-Dec 83 (manuscript received 13 Jun 83) pp 66-72

BELOBORODOV, M. A. and KOGEN, V. S., "Aerogeologiya" Production Geological Association, Moscow

[Abstract] A method is suggested for comparative evaluation of information yielded in the search for minerals through the interpretation of space images. The degree of information in the characteristics considered when predicting mineralization and the assessment of risk in surveying for various kinds of mineral-bearing structures, proceeding from the results of prediction, are suggested as criteria for such a method. Criteria are defined and the mathematical apparatus described. The method is used by way of example to assess the mineralization of the Aldano-Stanovo region using data obtained from the ASPO-8 automated system. Space image interpretation was done on the basis of 68 characteristics defined for the area under study, using 1 x 1 cm cells each containing 5,660 pixels. It is shown that the method enables significant information to be derived for predicting mineralization when space image interpretation is combined with geological, geophysical and geochemical studies. It is pointed out that a classification of mineral objects as seen on remote images and improvements in interpretation methods for geological, geophysical and geochemical data would improve the reliability of the method. References 3 (Russian).
[61-9642]

UDC 528.77:550.814+629.78

GEOLOGICAL INTERPRETATION OF SPACE IMAGES OF ANTARCTICA

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 6, Nov-Dec 83 (manuscript received 31 May 83) pp 52-59

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[Abstract] Studies of space images of areas in the Antarctic enabled interpretation of relief on the surface of the ice cover and down to a depth of

1.5 kilometers below its surface. Analysis showed that bedrock relief at depths of tens of hundreds of meters below the surface of the ice cover tends to be smooth. At deeper depths structures 5-10 kilometers in size can be distinguished. Since sub-ice structures tend to be inherited landforms it is possible to determine the form of the underlying bedrock from surface features. Tectonic features in the area studied are of four types: least stressed blocks, which include the Shackleton Range; weakly stressed blocks, as, for example, the Theron Mountains, and two other blocks encompassing the Argentina Range and the Whichaway, Hopalong and Omega nunataks; blocks under moderate pressure on the glacial bed in the region of sluggish glaciers; and blocks with maximum pressure on the glacial bed, in particular the Slessor and Recovery glaciers and a substantial part of the Filchner Ice Shelf. The geological features of these four categories are discussed. These and other interpretations of space images of the mountainous regions of Antarctica show that field observations are not required to confirm the features of geological structures, in particular disjunct tectonics, as interpreted from space images. Figures 3; references 12: 10 Russian, 2 Western.
[61-9642]

UDC 551.24.035:629.78

## USE OF SPACE IMAGES TO RECONSTRUCT MOST RECENT FIELD OF TECTONIC STRESSES

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 6, Nov-Dec 83 (manuscript received 15 Jun 83) pp 39-51

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[Abstract] Images of the Altay-Baykal mountain field obtained from aboard "Meteor" artificial Earth satellites were reconstructed at a scale of 1:2,500,000 and tectonic studies were done of the morphology and structure of the Sayan-Tuva area. Tectonic stress fields formed during the Upper Tertiary and Quaternary periods were reconstructed and analyzed. A detailed description is given of the relief and geological structures in the area studied, and findings are compared with results from earlier studies. It is shown that the most recent structures in the area were formed as the result of a northeasterly compression of the mantle accompanied by dynamic effects from deep disturbed masses and deformation of the initial pressure field associated with block cleavage into zones and individual morphologic structures. Analysis of the space images in some cases enables detection of signs of restructuring with time, indicating reorientation of the pressure field during the Tertiary and Quaternary periods. It is concluded that reconstruction of space images can be of use in analyzing the most recent geodynamics and seismic activity and may be adequate to determine the dynamic tectonic situation in the age of block formation in the Mesozoic and Cenozoic. Figures 3; references 22: 19 Russian, 3 Western.
[61-9642]

UDC 551.042:629.78

SIGNIFICANCE OF SPACE IMAGE GENERALIZATION IN METALLOGENIC ANALYSIS (USING CAUSCAUS AS EXAMPLE)

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 6, Nov-Dec 83 (manuscript received 22 Oct 82) pp 73-82

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[Abstract] Criteria used in generalization of space images in metallogenic analysis are discussed. Generalization is classified according to the scale and resolution of the remote images and the dimensions of the geological objects, providing complete, almost complete or partial generalization. Information used in metallogenic analysis is categorized according to generalization as follows: rupture dislocations (subcategories: global, transcontinental, straight-through, regional), folded-block structures, ring structures, formations, and zones of hydrothermal change. Each of these categories is discussed with reference to remote images of the Caucasus area obtained from "Zond," "Meteor" and "Landsat" satellites and "Soyuz" and "Salyut" ships at scales ranging from 1: 200,000 to 1: 25,000,000. Maps are shown for the area studied, highlighting the major categories examined. It is concluded that image generalization enables use of remote imaging data to analyze ore-bearing areas by interpreting patterns in the geological structures and the conditions in which minerals are formed and distributed. Figures 3; references 14 (Russian).
[61-9642]

UDC 528.7:629.78

PRESENTATION OF REMOTE SENSING DATA USING REFERENCE OBJECT

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 6, Nov-Dec 83 (manuscript received 19 Jul 83) pp 102-106

GOGOKHIYA, V. V., State Scientific Research Institute of Natural Resources, Moscow

[Abstract] The problem of optimal parametrization of results from remote sensing is considered for the case of unidimensional handling of data divided into families formed within a relatively narrow interval using an averaged execution associated with a reference object. Differential equations are derived using spectral signatures. Approximation and accurate values for a series of spectral signatures are compared and it is shown that the equations yield closer approximate values that those obtained using the linear method. Deviation of approximation realizations from true values is analyzed and shown to decrease as the number of representations is increased. It is concluded that the proposed method is particularly effectvie when describing a large

number of close realizations, a situation that frequently arises in the compilation of various kinds of data banks. Introduction of the reference function enables less frequent selection of network steps and thus considerably reduces the number of references. No references.
[61-9642]

UDC 528.7:681.3

METHOD FOR PARALLEL COMPUTATION OF GEOMETRIC PARAMETERS FOR OBJECTS ON OUTLINE IMAGES

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 6, Nov-Dec 83 (manuscript received 27 Apr 83) pp 107-114

FEYGIN, M. M., Special Department for Projects and Research, "Soyuzgiprovodkhoz" Institute, Moscow

[Abstract] A method is proposed for secondary machine processing of remote sensing images by means of computing the metric characteristics of isolated objects, a process essential in solving geological, geophysical and other problems using remote sensing data. The problem is presented in terms of the matrix required for the computer memory. A method of parallel computation is shown. The basic idea of the method is that any numerical characteristic (length, area and so forth) in a given field can be evaluated and presented as an integral characteristic which is a function of an upper limit. A method is shown for analyzing these characteristics. Am algorithm is derived for executing the method and its operation is described. The algorithm enables computation of areas of associated fields of eandom form or the total lengths of outline images. The method was used on an experimental system using FORTRAN-80 and FORTRAN-RAFOS, employing an MDS-231 "Intel" computer for a comparative computation of the areas of objects during map comparison. Results were displayed from line-by-line scanning of map outlines. Details of the system parameters are given. Figures 4; references 3 (Russian).
[61-9642]

SPACE POLICY AND ADMINISTRATION

## PRAVDA EDITORIAL ON SUCCESSFUL COMPLETION OF LYAKHOV-ALEKSANDROV FLIGHT

Moscow PRAVDA in Russian 27 Nov 83 p 1

[Editorial: "Congratulations on Your Triumph, Heroes of Space"]

[Excerpt] This expedition was remarkable and unprecedented in many respects. A great deal of scientific and technical research and experimentation having major scientific and national economic significance was performed. The information obtained in the program of research into our country's natural resources and study of the environment is vast. Yet anther step forward was made in developing and testing the technological processes and equipment which are laying the fondation for space factories to turn out new materials and medicinal preparations. Biological and technical experiments were conducted, and instruments and equipment of prospective space devices were tested.

The high point of the nearly five-month flight was performance of unique repair operations in space--the installation of supplementary solar batteries which substantially increase the electric power capabilities of the station and permit broadening of the research program aboard it. In coping with this work, demanding skill and courage, V. A. Lyakhov and A. P. Aleksandrov inaugurated an essentially new stage in manned flight practice, hastening arrival of the day of assembly in orbit of the massive structures of the future.

This combination of important practical results, awaiting applications in today's science, technology and the national economy, together with an orientation toward the future and a resolve to blaze trails no one else has tried perhaps best of all characterizes the expedition just condluced. The expedition just concluded. The expedition proved anew that Soviet cosmonautics, confidently and step by step, is unfolding its basic direction--the creation of complex manned orbital assemblies which, in the course of prolonged operation, may be improved and reconstructed according to the nature of assigned goals. The new success attained on this path confirms how important it is in scientific work to follow the course laid down in the resolution of the CPSU Central Committee and USSR Council of Ministers "On measures toward expediting scientific and technical progress in the national economy"--and further concentrate the potential of scientific research and design organizations upon solving problems which will ensure satisfaction of current as well as prospective requirements of the national economy.

The horizons of our cosmonautics are boundless, indeed. The arsenal of its technical resources is diversified as never before. Its scientific and national economic yield grows from flight to flight. Artificial earth satellites conduct scientific exploration; relay television transmissions; help forecast the weather, locate the resources of earth's interior, protect nature and direct oceangoing ships on voyages by the most advantageous routes; and they have mastered dozens of other "occupations". The excellent potentials of domestic space technology are a pledge of further expanding the sphere of this activity. Achievements here will be the more impressive, the more persistent is the care taken steadily to increase the effectiveness of research work and to obtain the active cooperation of scientific associations in large-scale introduction of the scientific achievements into industry. And not just into the space industry--It is necessary to strengthen the practical ties of cosmonautics with the various branches of the national economy, and to try to have cosmonautic capabilities put into service in each of them, operationally, skillfully and in full measure.

The contribution to the peaceful conquest of outer space of the Land of the Soviets--first traveler of extraterrestrial routes--has won international recognition. The Soviet Union initiated widespread international co-laboration in this sphere of activity, and our country has been initiator and participant in all currently effective agreements aimed at ensuring the use of space only for the good of mankind. The USSR resolutely opposes the attempts of imperialists to turn space into a source of mortal danger for people. As comrade Yu. V. Andropov remarked, "...The Soviet Union Will exert its maximum effort even further toward the end that sinister plans for transferring the arms race into space do not become reality." This noble position fulfills the hopes of the Soviet people, and all people of good will on the planet are in complete agreement with it.

The remarkable new triumph in space is a fruit of the constant, unremitting attention of the Communist Party and the Soviet State to the development of science and technology. It inspires the Soviet people to finish the task assigned by the Party--to combine in practice the advantages of our socialist system with the achievements of the very latest stage of the scientific and technical revolution. Cosmonautics is one of the key sectors in the broad front of exploration by Soviet scientists, who are creating the machinery, devices and technology of the present as well as the future. May success accompany all participants in this honorable and responsible work.

12319
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COMMENTARY ON U.S. MILITARY PLANS FOR SPACE

Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 5, May 83 pp 46-47

[Article by Engr-Col E. Buynovskiy, candidate of engineering sciences: "The Pentagon Bursts into Space"]

[Text] According to foreign press information.

There have been appearing ever more frequently in the Western press recently reports that preparations are under way in the US to create a new theater of military operations--space, it being put across, as before, under the aegis of "national security." Hiding behind the "Soviet military threat," imperialism is masking its aggressive essence, deceit and hypocrisy, and the striving to achieve world domination by any means.

Back in 1957-1958 the U.S. Department of Defense planned to develop a number of space systems for military strategic purposes. It was then that the task was set of creating a complex capable of bombing terrestrial targets (the "Dyna-Soar" program and the "Bambi" design). In accordance with the "Saint" program, means were developed for the identification, interception and destruction of enemy spacecraft. And only the lack of the appropriate scientific and technical potential compelled Pentagon fighters to temporarily drop the idea of keeping the globe constantly in their sights.

In all the following years, in creating and improving spacecraft for reconnaissance, communications, navigation and meteorological support, the Pentagon's strategists have not forgotten either about the development of spacecraft for pressure and aggression. And now the timid comments of foggy content are replaced in our day by whole treatises about more effective weaponry.

Back at the end of the 1970's, in President Carter's time, the magazine BUSINESS WEEK fairly accurately formulated the Pentagon's position in regard to the potential opportunities of near-earth space: "He who is able to take control of space--this main arena of future wars--will be able to change the relationship of the forces so decisively that it will amount to the establishment of world domination."

In 1980 the knowledgeable magazine AVIATION WEEK AND SPACE TECHNOLOGY published an article under the title, "Pentagon Studies the Possibility of Creating a Space Station for Combat Application with Laser Weaponry Aboard." This was not a polemic on the topic of whether there should or should not be death-dealing weaponry in space, but a purely American, businesslike approach to just what type of laser weapon is most acceptable for destroying various targets, with the lament, true, at the fact that research work in this direction is not being conducted intensively enough.

The new splash of imperialist hysteria in the US was given a push by a directive of the President of the US that was published in July last year about a national space policy. This document has already been mentioned in the press. And still it is worthwhile to pay attention to one fact. The directive asserts that the space systems of any country are its national property with the right of unhindered movement in near-earth space. The deliberate interference in the activity of any systems will be viewed as an infringement on sovereign right. And here it is, literally in a nutshell: the US will deprive any enemy of the possibility of using "space-based systems that are intended for sending support to enemy armed forces."

How categorically--"will deprive"! It turns out that only U.S. satellites have the sovereign right to fly unhindered. Others are deprived of it: try to prove that the information obtained will not be used in the interests of the armed forces. This is truly a high-handed intention to win world leadership in space!

How did the U.S. Department of Defense interpret the president's directive? The U.S. Assistant Secretary of Defense for Scientific Research reported on this in September 1982. According to his statement, serious attention is being paid to the creation and development of satellite systems of communications, navigation, observation of the ocean's surface, and the detection of ICBM launches. This refers, in particular, to the creation of a Milstar satellite system of communications whose information will be used by the strategic nuclear forces, the Navy, the Rapid Deployment Force, and the Air Force. It is also proposed to expand the functions of the Navstar navigation system, supplying it with "lords" instruments for observing nuclear explosions.

Let us note that all these means, according to the definition of the "Pentagon directive," are space systems "for the support of the armed forces." But remember, they are indeed of American origin. Consequently, they have all the rights to unhindered functioning?

Much attention was paid in the report to the possibilities of using the MTKK [reusable transport spacecraft], the Space Shuttle, in international military operations. The press of capitalist countries recently informed readers in detail about the far-ranging U.S. Department of Defense plans that are associated with this promising transport system. Research is also being conducted on the creation of a "nonnuclear antisatellite potential" with a view "to neutralizing the Soviet threat." What does this mean, and what Soviet satellites are they talking about? Perhaps about the satellites that enable radio to be heard and television to be seen in remote corners of our planet, or

about the satellites that help those ships and aircraft that have fallen into distress (incidentally, even American too), or about the satellites that forecast the weather and search for minerals?

These questions are legitimate: what kind of a threat can these satellites present for ground, naval or aerospace forces of the US? Why does the Pentagon need an antisatellite system? Here, as is said, the ends do not meet for the American military strategists.

Under the tireless attention of the Pentagon, a space laser weapon system is being created. Reliance is placed upon the use of two types--longwave and shortwave. In the specialists' opinion, both possess great potential.

For the creation of a shortwave laser, the U.S. Congress allocated 47.6 million dollars for the fiscal year 1983, 20 million dollars more than the Department of Defense asked for. Another 20 million dollars was allocated additionally for research in the area of vulnerability and for assessment of the combat effectiveness of this threatening weapon. If required, the Department of Defense will be allotted additional appropriations for these purposes.

It is noteworthy that, among the factors that determine the effectiveness of use of a space-based laser weapon, "the capability of the Russians to provide its potential targets with a strengthened defense" is also mentioned. What was meant by a "potential target"--a peaceful object or a weapon of attack--the reporter did not consider it necessary to explain. And this was not even in his interests.

Somehow, none of this tallies very much with the U.S. Secretary of Defense's assurances that "we are not militarizing space," "we are not preparing to transform the shuttle spacecraft...into a platform for deploying armaments" and his agency's actions do not contradict "the existing regime of international law." They do contradict. I should say so!

In recent years the U.S. Department of Defense has undertaken a number of concrete practical measures aimed at further centralizing control. In 1979 a directorate was formed within the framework of the Air Force weapons systems command (AFSC) and given the basic mission of creating and operating satellite systems of reconnaissance, communications, and meteorological and navigational support. Then there were organized within the Department of Defense a Space Directorate, a Committee for Operations that coordinates all programs for research and the use of spacecraft; and a Flight Control Center (SZOS [transliterated]), with the functions of controlling satellites for military purposes and for controlling Space Shuttle system flights in the interests of the Department of Defense. Courses for preparing future leaders for military space operations have been opened up in the Air Force Technology Institute.

All these organizational measures were executed within the framework of preparation for the creation of an Air Force Space Command, which officially began to function on 1 September 1982. As a commentator for AVIATION WEEK AND SPACE TECHNOLOGY states, the decision to create it was dictated by the ever-growing dependence of the U.S. armed forces upon space systems and, ostensibly, by

new threats on the part of the potential opponent. Without being precise about how the U.S. is being threatened and by whom, the magazine further emphasizes that "operations in space have reached such a maturity and become so important for the Air Force that it is necessary to attach the same importance to these operations as to the operations of strategic, tactical and military-transport aviation."

This is the general direction of the Pentagon's policy in the matter of developing and using space.

The Reagan administration needs the familiar political trick of the U.S.'s lag behind the USSR in military affairs primarily for an unprecedented buildup in the pace of the continuing arms race.



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LAUNCH TABLE

LIST OF RECENT SOVIET SPACE LAUNCHES

Moscow TASS In English or Russian various dates

[Summary]

| Date | Designation | Orbital Parameters | | | |
|---|---|---|---|---|---|
| | | Apogee | Perigee | Period | Inclination |
| 14 Dec 83 | Cosmos-1514 | 288 km | 226 km | 89.3 min | 82.3° |
| | | (Carries biological objects and radiation equipment; experiments will be performed on adaptation to zero-gravity and radiation protection; several experiments will be performed "in the framework of international cooperation for peaceful exploration of space") | | | |
| 15 Dec 83 | Cosmos-1515 | 676 km | 648 km | 97.8 min | 82.5° |
| 21 Dec 83 | Molniya-3 | 40,635 km | 645 km | 12 hrs 16 min | 62.8° |
| | | (Communications satellite for long-range telephone and telegraph communication and transmission of USSR Central Television points in the "Orbita" network) | | | |
| 27 Dec 83 | Cosmos-1516 | 299 km | 205 km | 89.2 min | 65° |
| 27 Dec 83 | Cosmos-1517 | (No orbital parameters reported; "after fulfilling the flight program, Cosmos-1517 performed a controlled descent in the atmosphere and splashed down in the planned are of the Black Sea; scientific research envisaged by the program has been completed") | | | |
| 28 Dec 83 | Cosmos-1518 | 39,345 km | 614 km | 11 hrs 49 min | 62.8° |

| Date | Designation | Orbital Parameters | | | |
|---|---|---|---|---|---|
| | | Apogee | Perigee | Period | Inclination |
| 29 Dec 83 | Cosmos-1519, -1520, -1521 | 19,100 | -- | 11 hrs 14 min | 64.3° |
| | | (Near-circular orbit; 3 satellites launched by single booster; to test elements and equipment of a space navigation system which is being created to determine location of USSR civil aviation aircraft and ships of merchant marine and fishing fleets) | | | |
| 5 Jan 84 | Cosmos-1522-- Cosmos-1529 | 1,510 km | 1,449 km | 115 min | 74° |
| | | (Eight satellites launched by single booster) | | | |
| 11 Jan 84 | Cosmos-1530 | 391 km | 206 km | 90.1 min | 72.8° |
| 11 Jan 84 | Cosmos-1531 | 1,023 km | 994 km | 105 min | 82.9° |
| 13 Jan 84 | Cosmos-1532 | 382 km | 178 km | 89.8 min | 67-2° |
| 26 Jan 84 | Cosmos-1533 | 382 km | 235 km | 90.4 min | 70.4° |
| 26 Jan 84 | Cosmos-1534 | 519 km | 470 km | 94.5 min | 65.8° |

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26 March 1984